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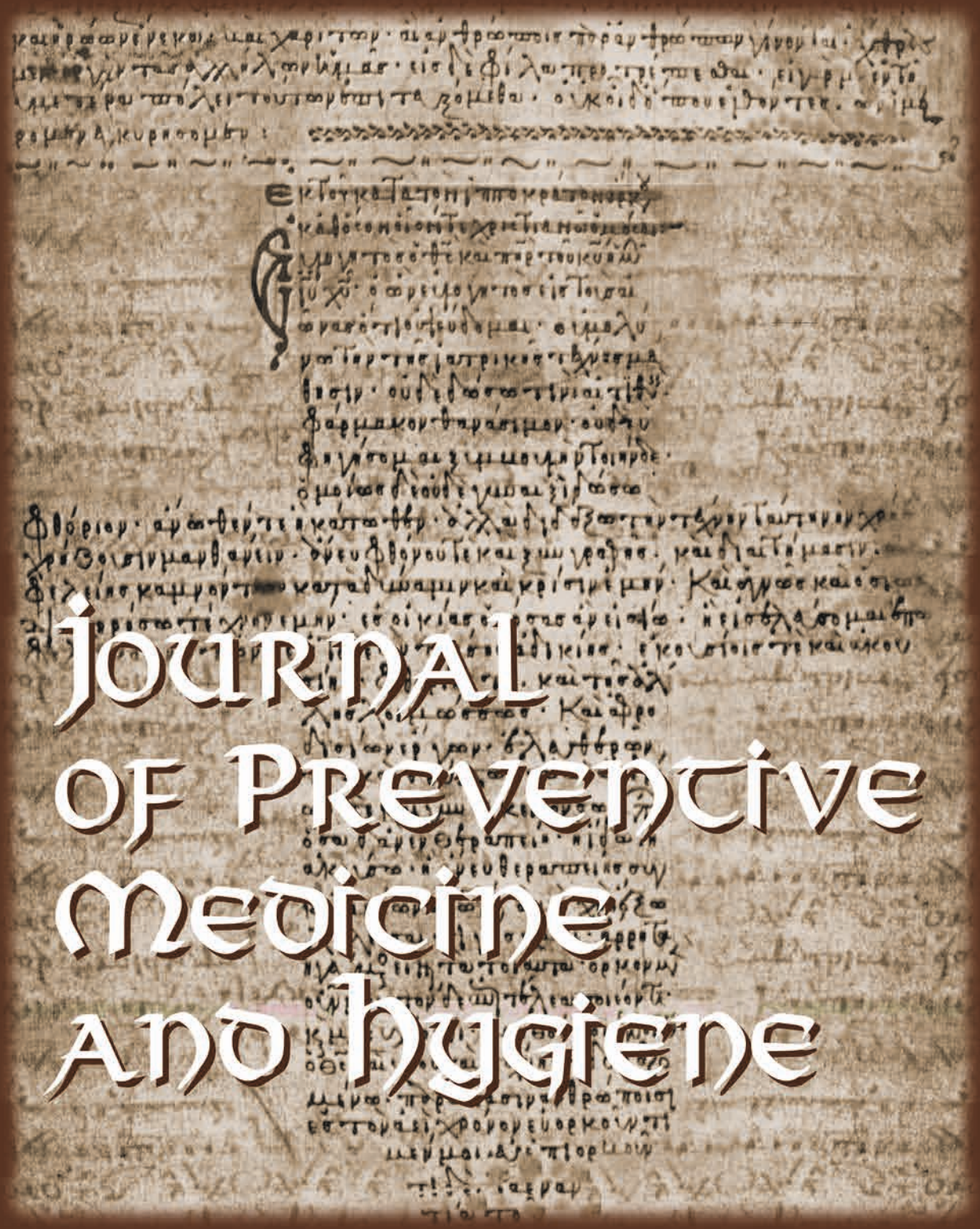

The original document of Hippocrates' oath

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EDITORIAL

Beyond Bombs: The Silent Public Health Crisis of War Dust

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Keywords

War • Dust • Public Health Preparation • Materials

Dear Editor,

At present, a large-scale war is unfolding in the Middle East. The parties involved have openly declared hostile positions and continue to attack one another, while other nations maintain that they are not part of the conflict. Yet is war merely about machines, aircraft, and missiles? War is undeniably a humanitarian tragedy. Yet, while the international community focuses primarily on the visible consequences *i.e.* loss of life and the collapse of health services in ongoing conflicts, another, quieter public health disaster is taking place. This crisis may persist long after the war itself has ended.

When residential buildings, hotels, and industrial areas are leveled by powerful explosions, they release vast amounts of dust containing hazardous materials, including asbestos fibers, lead, mercury, and residues from advanced munitions, whether detonated or unexploded. In addition, remnants of radioactive materials may disperse into fine particles, binding to the dust of destroyed structures. Cities flattened to the ground may symbolize military dominance, but they also generate toxic legacies for the future, affecting anyone exposed. These particles pose a persistent and life-threatening risk to civilian populations, especially to children, who inhale these toxins daily.

Research on dust particles generated from the collapse of the World Trade Center (WTC) has demonstrated substantial health risks. WTC dust was found to contain metals, asbestos, polycyclic aromatic hydrocarbons (PAHs), and persistent organic pollutants (POPs), including polychlorinated biphenyls (PCBs) and dioxins, as well as benzene [1]. Exposure to such materials has been shown to trigger inflammation throughout the respiratory tract, including the pulmonary system, and may also pose significant risks to the cardiovascular system [2, 3].

Finer particles are capable of penetrating deeper into the body, even reaching critical areas involved in maintaining the central nervous system [4]. Other reports have further indicated that such exposure may increase the risk of multiple myeloma (MM) and prostate cancer [5, 6]. Notably, these findings are based solely on dust generated from the collapse of two towers.

This risk is even greater in war zones, where buildings and infrastructure are destroyed almost daily. Continuous exposure to dust, both indoors and outdoors, becomes unavoidable, spreading across streets, homes, shops, and even shelters. Fine particles are likely to be extensively inhaled by populations in conflict areas and may be further dispersed through human mobility as people move in response to the dynamics of war. In addition, the distribution and persistence of this dust are influenced by weather conditions across affected regions. Over time, this environmental burden may lead to a decline in lung capacity and increase population vulnerability to the resurgence of infectious diseases such as tuberculosis and pneumonia. As a result, many health conditions, including cancers, may not manifest immediately and can remain unrecognized in the short term [7]. However, in the long run, these exposures may accumulate as a significant burden on population health, with consequences that may only fully emerge two to three decades later.

War zones, therefore, function as concentrated sources of toxic dust. Allowing this situation to persist is tantamount to condemning entire populations to a future marked by prolonged suffering. We must regard this systematic environmental destruction with deep concern, as it constitutes a long-term assault on humanity itself.

Without intending to impose stereotypes on populations living in conflict zones, there is an urgent need to begin systematically developing exposure databases related to toxic dust in these settings. Existing literature on dust exposure, including studies from the World Trade Center (WTC) disaster, provides a valuable foundation for identifying key components and associated toxic elements, enabling more targeted and evidence-based response strategies.

Looking ahead, a coordinated effort from public health community is needed to characterize the chemical profile of debris in war-affected areas. This includes mapping potential contaminants and aligning them with existing toxicological and epidemiological evidence. Such an approach would allow for the early preparation of health systems, including equipping healthcare workers with the knowledge and tools to recognize, monitor, and manage both acute and long-term health effects associated with these exposures.

At the same time, establishing longitudinal surveillance systems and exposure registries will be critical for tracking health outcomes over time. These data infrastructures can support early detection of disease patterns, inform preventive interventions, and guide policy responses in the post-conflict phase. Importantly, such efforts must be conducted with sensitivity, avoiding stigmatization while prioritizing protection and care for affected populations.

While we all hope for an immediate end to war, public health preparedness cannot wait. When the conflict subsides, another, less visible "war" will emerge, the long-term battle against the health consequences of toxic dust exposure. Anticipating this reality, and acting upon it now, is essential to mitigating a future burden that would otherwise unfold silently over decades.

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Conflict of interest statement

None.

Authors' contributions

All authors equally contributed to the conception, design, execution, and manuscript preparation.

References

[1] Tuminello S, Durmus N, Snuderl M, Chen Y, Shao Y, Reibman J, Arslan AA, Taioli E. DNA Methylation as a Molecular Mechanism of Carcinogenesis in World Trade Center Dust Exposure: Insights from a Structured Literature Review. Biomolecules 2024;14:1302. https://doi.org/10.3390/biom14101302.

[2] Hernandez M, Harrington A, Ma Y, Galdanes K, Halzack B, Zhong M, Vaughan J, Sebasco E, Gordon T, Lippmann M, Chen LC. World Trade Center Dust induces airway inflammation while promoting aortic endothelial dysfunction. Toxicol Appl Pharmacol 2020;400:115041. https://doi.org/10.1016/j.taap.2020.115041.

[3] Chen YT, Li J, Chang JN, Luo YC, Yu W, Chen LC, Yang JM. Transcriptomic analysis of World Trade Center particulate Matter-induced pulmonary inflammation and drug treatments. Environ Int 2023;177:108027. https://doi.org/10.1016/j.envint.2023.108027.

[4] Hernandez M, Vaughan J, Gordon T, Lippmann M, Gandy S, Chen LC. World Trade Center dust induces nasal and neurological tissue injury while propagating reduced olfaction capabilities and increased anxiety behaviors. Inhal Toxicol 2022;34:175-88. https://doi.org/10.1080/08958378.2022.2072027.

[5] Wu K, Li L, Thakur C, Lu Y, Zhang X, Yi Z, Chen F. Proteomic Characterization of the World Trade Center dust-activated mdig and c-myc signaling circuit linked to multiple myeloma. Sci Rep 2016;6:36305. https://doi.org/10.1038/srep36305.

[6] Gong Y, Wang L, Yu H, Alpert N, Cohen MD, Prophete C, Horton L, Sisco M, Park SH, Lee HW, Zelikoff J, Chen LC, Hashim D, Suarez-Farinas M, Donovan MJ, Aaronson SA, Galsky M, Zhu J, Taioli E, Oh WK. Prostate Cancer in World Trade Center Responders Demonstrates Evidence of an Inflammatory Cascade. Mol.Cancer Res 2019;17:1605-12. https://doi.org/10.1158/1541-7786.MCR-19-0115.

[7] Shao Y, Durmus N, Zhang Y, Pehlivan S, Fernandez-Beros ME, Umana L, Corona R, Addessi A, Abbott SA, Smyth-Giambanco S, Arslan AA, Reibman J. The Development of a WTC Environmental Health Center Pan-Cancer Database. Int J Environ Res Public Health 2021;18:1646. https://doi.org/10.3390/ijerph18041646.

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Editor's response

Dear Dr. Fotarisman Zaluchu,
There is no doubt that the debris from explosions generates toxic and carcinogenic dust that can affect humans even after a long period of time. The most striking example is the damage suffered by the people of Hiroshima and Nagasaki.
Still on the subject of radioactive dust, it's important to remember that radionuclides such as Radon-222 are present in the soil and building materials of homes, and that this radionuclide is the second leading cause of lung cancer after smoking.
What is certainly difficult is controlling the bombed areas. Indeed, the measures that should be adopted include: closing off these areas, with only rescue workers allowed access; providing them with personal protective equipment, such as FFP3 masks; and spraying water as soon as possible to capture and precipitate fine dust particles. Furthermore, the soil should be washed, possibly with additives (such as surfactants, acids, chelating agents, etc.); covering the debris with sheets could also be helpful. Whenever possible, contaminated soil should be removed and transported to suitably equipped washing facilities. Finally, the affected area should be monitored, especially for fine particulate matter (PM10 and PM2.5).
It is clear that cleaning up a bombed area is not one of the easiest interventions to implement.
In conclusion, what is most astonishing is that humanity, who has implemented laws and technologies to protect populations from air pollution, can then compromise air quality, the quality of life, and the health of populations with the cruel instrument of war.

Infectious disease

A five-season regional analysis of influenza-related indicators in Piedmont, Italy: insights from comparison with national trends

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Keywords

Influenza-like illness • Influenza vaccination • Excess mortality • Surveillance

Summary

Introduction. *Influenza remains a major public health concern, while vaccination coverage has persistently remained below national targets. This study aimed to describe influenza-related indicators in Piedmont over five influenza seasons and to compare regional findings with national data to inform current prevention strategies.*
Methods. *A descriptive analysis of the 2019/2020-2023/2024 influenza seasons was conducted using publicly available data from Piedmont and Italy. Weekly and cumulative Influenza-Like Illness (ILI) incidence were assessed overall and by age group. Virological surveillance data were used to describe circulating influenza strains, excess mortality among adults aged ≥65 years was estimated by comparing observed and expected weekly average daily deaths, and influenza vaccination coverage was analysed overall and by age group.*
Results. *Overall cumulative ILI incidence increased during the study period, despite a marked reduction in 2020/2021. Piedmont generally showed higher ILI incidence than Italy. Although children remained the most affected group, the gap between paediatric and adult/older age groups progressively narrowed, with a growing absolute burden among adults and older adults. Virological surveillance showed substantial variability across seasons, with influenza A predominating in most years. Excess mortality was highest in 2019/2020 and 2020/2021 and was generally more pronounced in Piedmont than nationally. Vaccination coverage improved compared with the pre-pandemic period but remained below national targets across key population groups.*
Conclusion. *Influenza-related burden in Piedmont remained considerable over the study period. These findings support the need for stronger vaccination strategies and integrated epidemiological, virological, and mortality surveillance to guide timely and context-specific public health action.*

Introduction

Influenza represents a priority for public health: globally, the influenza-related hospitalization rate is 40.5 (95% CI=24.3-67.4) per 100,000 inhabitants, with higher hospitalization rates among children up to 4 years old and adults over 65 years [1]. Although most estimates of the global burden of influenza disease focus on respiratory complications, the possible consequences of influenza include worsening of underlying chronic conditions, increased susceptibility to secondary infections, cardiovascular events, and functional decline [2].
Specifically, in Italy, the influenza attack rate is estimated to range between 13% and 31%, depending on the circulating virus strain during the season, and only about 18-29% of infections are detected by the surveillance system. While people aged over 65 do not represent the group most frequently contracting influenza [3], this age group reports the highest rates of complications and deaths [4]. Italian estimates indicate that the majority of influenza-related deaths (65%-96%) occur in individuals aged 65 or older; moreover, the excess mortality rate in the elderly is more than six times higher compared to the general population [4].
Vaccination is one of the key strategies to reduce the impact of influenza. Although real-world effectiveness varies depending on the virus type and the age of the infected individuals, vaccines have proven effective in reducing the risk of hospitalization [5]. Vaccines have also proven effective, for example, in reducing cardiovascular complications in the older adults, thus representing a crucial ally in decreasing the disease burden associated with influenza [6]. In Italy, the National Vaccination Prevention Plan (PNPV) 2023-2025 [7] defines a minimum vaccination coverage target of 75% among people over 65 years old, with an optimal goal set at 95%. However, in Italy, influenza vaccination coverage among adults aged 65 years or older has never reached the recommended 75% target and has consistently remained at approximately 50%. Piedmont is among the regions that have persistently reported coverage levels below the national average [8].
Given the substantial burden of influenza and the persistently low vaccination coverage in Piedmont, this study aimed to describe the regional epidemiology of influenza and its associated health burden in the Piedmont population. In addition, by comparing regional

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findings with national data across five influenza seasons, the study sought to provide a broader perspective on current prevention strategies.

Methods

This report considers an observation period that includes five influenza seasons, from 2019/2020 to 2023/2024, in Piedmont. All analyzed data were obtained from publicly available online sources. Data management, statistical analyses, and graph production were conducted using Excel and Stata. Details on the data sources, study procedures, and statistical analyses are provided in the following sections.

Epidemiological Surveillance

In Italy, epidemiological monitoring of influenza is carried out through RespiVirNet (previously InfluNet until the 2022-2023 season), a surveillance system coordinated by the Italian National Institute of Health (ISS) [9]. The system consists of two main components: epidemiological surveillance and virological surveillance. The former aims to measure and describe the trend of Influenza-Like Illness (ILI) cases, while the latter focuses on detecting circulating respiratory viruses, including influenza viruses [10]. ILI is defined as an acute syndrome characterized by general symptoms (fever, malaise) and respiratory symptoms (cough, sore throat, runny nose), which can be caused not only by influenza viruses but also by other respiratory pathogens [10]. Information collected within the RespiVirNet epidemiological surveillance context refers to ILI. The system relies on the collaboration of sentinel physicians, including general practitioners (GPs), family pediatricians (PLS), and regional representatives of Local Health Authorities (ASL). To ensure adequate coverage, starting from the 2020/2021 season, the system increased the number of sentinel physicians, doubling coverage from 2% to 4% of the population, as reaffirmed by the Operational Protocol for the 2024-2025 season [10]. RespiVirNet employs a "zero-reporting" method, whereby sentinel physicians are required to report also the absence of ILI cases during a given week. Surveillance normally extends from week 42 of each year to week 17 of the following year [10].

To describe the epidemiology of ILI in Piedmont from the 2019-2020 to the 2023-2024 season, epidemiological data were extracted from weekly reports published by RespiVirNet [11]. Extracted data included the total number of ILI cases each week, the corresponding total number of population under surveillance, and the weekly ILI incidences overall and stratified by age groups (0-4 years, 5-14 years, 15-64 years, and 65 years and over). Incidences are expressed as the number of ILI cases per 1,000 monitored individuals.

To highlight any differences or similarities in the progression of the influenza epidemic at the regional and national level, corresponding national data were extracted and compared with the Piedmont data. Additionally, to assess temporal variations in the epidemic trend, data from the previous five seasons (2014/2015 to 2018/2019), *i.e.* before the COVID-19 pandemic, were also extracted. This paper also presents the average values for the seasons from 2014/2015 to 2018/2019 and for the five-season observation period from 2019/2020 to 2023/2024.

To evaluate the overall cumulative incidence of ILI in different seasons, an estimate was calculated starting from weekly ILI incidences by age group and for the total population in Piedmont and Italy. Given the variability in the monitored population each week, the weekly incidence was first multiplied by the population as of January 1 of the reference year (*e.g.*, population on January 1, 2020, for the 2019/2020 season) to estimate the number of cases in Piedmont and Italy for that week. The cumulative incidence was then calculated by summing the estimated weekly cases and dividing by the population as of January 1 of the same year; this result was multiplied by 100 to obtain the cumulative incidence. For Piedmont, the estimated number of cases per influenza season is also reported, noting that estimates may be underestimated due to missing data in some weeks (Tab. S1). Considering that cumulative incidence in Piedmont was calculated over fewer weeks than the national cumulative incidence, the Italian cumulative incidence was recalculated by considering only the weeks for which Piedmont data were also available to ensure comparability of data.

Line charts were produced to visualize the trend of total ILI cases across seasons separately for Piedmont and Italy, including the average of the 2014/2015 to 2018/2019 seasons and those of the observation period. For each of the last five influenza seasons and for the average of the previous five years, a graph was created showing the weekly incidence trends of ILI for both Italy and Piedmont.

As a measure of intensity of ILI incidence in different seasons in Piedmont, maximum weekly incidences and the corresponding weeks of observation were reported for the total population and stratified by age group. To measure the epidemic period in each influenza season, weeks marking the start and end of the epidemic, the peak week, and the duration of the epidemic were identified for Piedmont and Italy. The epidemic period was defined based on a weekly incidence threshold according to Boccalini et al. [12]. Specifically, the start week was identified as the first week in which the weekly incidence was ≥2 cases of ILI per 1,000 monitored individuals, while the end week was the first week in which incidence fell below this threshold without rising above it again.

Virological Surveillance

As for Piedmont, virological surveillance reports [11] allowed extraction of the number of weeks during which samples were collected and sent and the number of weeks during which each influenza virus strain (unsubtyped influenza A, H1N1pdm09, H3N2, and B) was detected for each season of interest. Percentages

of weeks in which each strain was observed were then calculated. Corresponding national data were extracted for comparison. Additionally, for Italy, data on the number of positive swabs were obtained from the FluNews/RespiNews-Italia archive [13], and for each influenza season, the total number of influenza-positive swabs, the percentage positivity among total samples, and the percentage distribution of each influenza strain out of the total positive swabs were calculated. Data were not available for the 2014/2015 and 2015/2016 seasons.

Excess Mortality

To evaluate the disease burden associated with influenza, we compared observed and expected average daily deaths per week in the population aged ≥65 years, following a methodology similar to that used in the weekly Flunews-Italia bulletin by ISS [14]. Because influenza-specific mortality data are not available in real time and death certificates may underestimate the contribution of influenza, all-cause mortality is commonly used in surveillance systems as an indirect proxy to capture excess mortality temporally associated with influenza circulation [14]. Therefore, our estimates should be interpreted as excess all-cause mortality occurring during periods of influenza activity, rather than as deaths directly attributable to influenza.

Daily mortality data for Piedmont and Italy were extracted from ISTAT (Italian National Institute of Statistics) databases [15], considering the weeks of influenza seasons from 2014/2015 to 2023/2024, as defined by Piedmont ILI surveillance. Weekly total deaths and average daily deaths per week were calculated for each season.

Weekly total deaths were calculated, and the corresponding mean daily deaths were then estimated for each week of every influenza season. For each year of interest (from the 2019/2020 to the 2023/2024 influenza season), the expected mortality was estimated as the weekly mean daily mortality based on the historical series of the previous five years, weighted by the resident population as of 1 January of the reference year, following an approach similar to that used in the FluNews-Italia bulletin [16]. For each influenza season, the resident population as of 1 January of the calendar year in which the season ended was used (*e.g.*, 1 January 2020 for the 2019/2020 season), according to ISTAT data [17], to account for the progressive increase in the older population in recent years.

Observed and expected values of average daily deaths for Piedmont were graphically represented alongside ILI incidence in the ≥65 years age group. The association between observed mortality and ILI incidence was assessed using Spearman's rank correlation test. For each week, the percentage difference (delta) between observed and expected deaths was calculated. Weeks with the maximum and minimum deltas were identified to highlight periods of excess mortality. National mortality data were processed using the same methodology to allow regional-to-national comparisons.

Vaccination Coverage

Influenza vaccination coverage data for Piedmont and Italy are available on the website of the Ministry of Health [18]. Considering our five-year observation period, data on vaccination coverage were extracted, stratified by the following age groups: 6-23 months, 2-4 years, 5-8 years, 9-14 years, 15-17 years, 18-44 years, 45-64 years, and 65 years and over. For the previous five years, coverage data were only available for the 65+ category and total population.

Additional vaccination coverage estimates were obtained from the PASSI [19] and PASSI d'Argento [20] surveillance systems, which survey adults 18–64 years and those aged 65 and over, respectively. These systems monitor influenza vaccination uptake in the 12 months preceding the interview and provide stratifications by chronic condition status.

Results

Epidemiological surveillance

Cumulative incidence of Influenza-Like Illness (ILI)

Table I summarizes the total estimated cases of ILI in Piedmont during the reference period (from the 2019/2020 season to the 2023/2024 season) as well as in the preceding five-year period. Overall, the number of estimated cases increased during our observation period. However, there was a decrease in estimated cases among children and adolescents (0-14 years) and an increase among adults (15-64 years) and the older adults (≥65 years), with an inversion in the relative burden between younger and older age groups.

Considering the estimated cases in the Piedmont population, in the pre-pandemic seasons from 2014/2015 to 2018/2019, an average of 13.8% of the population was affected by ILI (range 11.4-15.6%). Although the average from the 2019/2020 to 2023/2024 season was 16%, the range of values is more variable: from 4.5% in the 2020/2021 season to 25.3% in the 2022/2023 season, followed by 21.6% in the 2023/2024 season, as shown in Table S2. Regarding age groups, in all seasons in the pre-pandemic seasons, the 0-4 (average: 55.2%) and 5-14 (23.8%) age groups had higher cumulative ILI incidences than adults (13%) and older adults (6%), which had the lowest cumulative incidence. In the most recent five-year period, although the younger age groups continue to have a higher cumulative incidence of ILI, the differences between age groups have narrowed.

For comparison, Supplementary Table S3 shows the cumulative incidence of ILI in Italy, calculated on the basis of estimated cases, considering both all available weeks and only those weeks for which data were also available for Piedmont. In Italy, in the pre-pandemic seasons from 2014/2015 to 2018/2019, it was estimated that an average of 11% of the population was affected by ILI, with an incidence lower than the Piedmont's data. Overall, even in the five-year period from the 2019/2020 season to the 2023/2024 season, a lower incidence was reported in Italy than in Piedmont. Similarly to Piedmont,

Tab. I. Estimated ILI cases by age group in Piedmont, influenza seasons 2014/2015 to 2023/2024.

Estimated ILI cases in Piedmont					
Season	**0-4 years**	**5-14 years**	**15-64 years**	**≥65 years**	**Total Population**
2014-2015	87,339	98,574	369,856	63,873	602,363
2015-2016	77,559	97,021	258,957	45,974	501,117
2016-2017	94,543	78,420	353,785	74,186	598,607
2017-2018	107,591	94,420	413,309	80,400	677,412
2018-2019	101,061	87,382	376,186	63,395	629,417
Average 2014/2015-2018/2019	**93,618**	**91,163**	**354,419**	**65,565**	**601,783**
2019-2020	51,258	62,038	292,612	55,932	523,123
2020-2021	9,464	9,035	152,076	33,458	190,791
2021-2022	66,303	81,491	441,847	78,313	710,513
2022-2023	67,346	112,525	685,735	172,072	1073,636
2023-2024	47,374	68,813	648,840	153,590	918,351
Average 2019/2020-2023/2024	**48,349**	**66,781**	**444,222**	**98,673**	**683,283**

Italy also showed a much lower cumulative incidence of ILI for the 2020/2021 season than in all other seasons. Furthermore, Italy also experienced a significant increase in ILI incidence during the 2022/2023 and 2023/2024 seasons compared with previous seasons (Fig. 1).

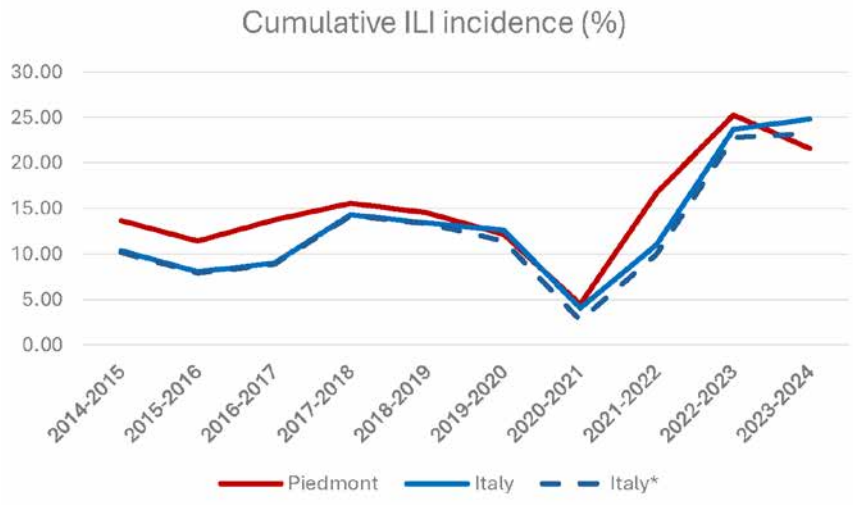
Considering the distribution by age group, in Italy during the pre-pandemic period, although the younger categories had higher cumulative incidences, the difference between age groups was less pronounced than in Piedmont. In the last five years, incidence has increased on average across all age groups, particularly in the 0-4 age group. Compared with Piedmont, in Italy the cumulative incidence of ILI is higher in the 0-4 age group, whereas it is slightly lower in the 15-64 and ≥65 age groups (Tab. S2 and S3).

In Piedmont, the highest weekly incidence was recorded in the 2022/2023 season, with a peak in week 50 (21.3 cases per 1,000 patients). Overall, the 2022/2023 season showed weekly incidence values consistently above the average observed from the 2014/2015 to the 2018/2019 seasons, with the exception of a few weeks (weeks 3-6). Higher peak values were also observed in the 2023/2024 season (16.4 cases per 1,000 patients). By contrast, the 2020/2021 season showed consistently lower values than all other seasons, with a peak of 3.3 cases per 1,000 patients in week 49 (Fig. 2; Tab. S4).

Table S4 reports the maximum weekly incidences for each season and the corresponding week, stratified by age group. The peak values for each age group reflect the pattern observed for cumulative incidences. Although the peaks across the different categories are highly variable, in three years the peak in the 0-4 age group preceded that in the ≥65 age group.

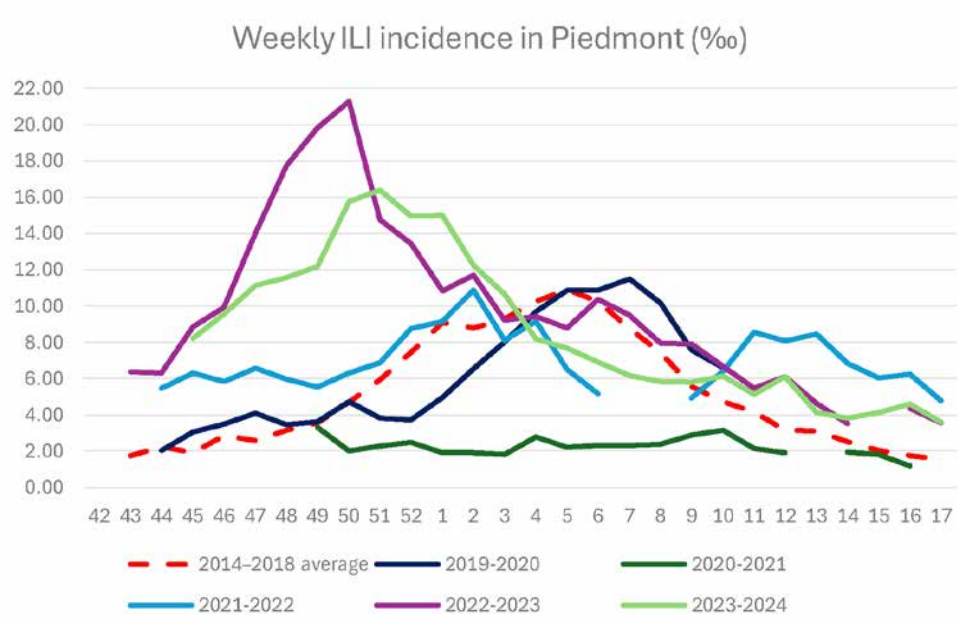
In general, over the last three years of our observation

Fig. 1. Total cumulative incidence of ILI (%) for the seasons from 2014/2015 to 2023/2024 in Italy and Piedmont (Italy*: estimate including only weeks also available for Piedmont).



Weekly incidence of Influenza-Like Illness (ILI).

Fig. 2. Weekly ILI incidence for the seasons from 2019/2020 to 2023/2024 and for the average of the seasons from 2014/2015 to 2018/2019 in Piedmont. Week 53 has not been included as it only occurred in 2020-2021.



period, the duration of the epidemic period has increased, with peaks occurring earlier compared to pre-pandemic seasons (Fig. 2; Tab. S5).

As in Piedmont, Italy also reported substantially higher maximum weekly incidences in the 2022/2023 and 2023/2024 seasons compared with other seasons, although the incidence in Italy was higher than in Piedmont for the 2023/2024 season. Similarly, the 2020/2021 season recorded significantly lower weekly incidences than all other seasons (Fig. S1). In Italy, the peak incidence has generally occurred earlier (with the exception of the 2021/2022 season), and the duration of the epidemic period, in terms of the number of weeks, has increased in the 2021/2022 season and subsequent seasons (Tab. S6).

Figure 3 graphically compares the weekly incidence of ILI in Italy and Piedmont during the reference seasons. Overall, ILI incidence was consistently higher in Piedmont than in Italy, with the exception of the 2019/2020 and 2023/2024 seasons.

Virological surveillance

Data from Piedmont indicate that, over our five-year reference period, the detection of different influenza strains was highly variable (Tab. S7). In the 2019/2020 and 2022/2023 seasons, both strain A and strain B were identified in most of the weeks in which samples were sent. In contrast, strain B was completely absent in 2021/2022 and present in only a few weeks in 2023/2024. It should be noted that in the 2020/2021 season, none of the analyzed samples tested positive for influenza.

Comparing this with the Italian situation (Tab. S8) over the last five years, the weekly pattern of strain presence was similar to that observed in Piedmont, except in the 2023/2024 season, when strain B was detected in almost all surveillance weeks at the national level. Even considering the entire country, no samples tested positive for influenza in the 2020/2021 season.

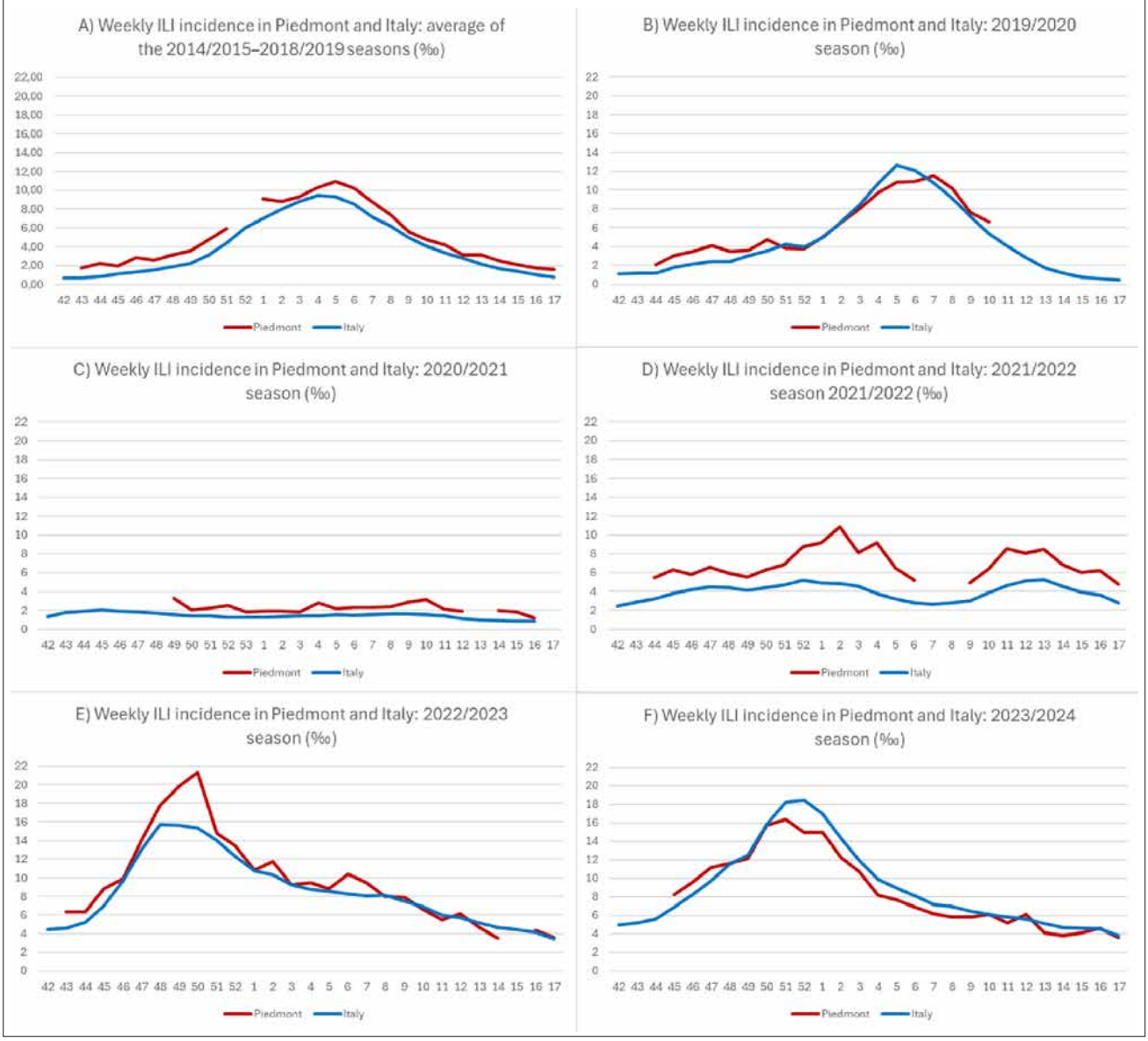
Although these data were not analyzed for Piedmont, some Italian data are presented in Table S9 and Figure 4 to better characterize the seasons of interest. Table S9 shows an overall lower percentage of influenza-positive samples compared with pre-pandemic seasons. Figure 4 illustrates the distribution of influenza-positive samples between strains A and B, showing a clear predominance of strain A in all seasons except 2017/2018.

Excess mortality

Marked excess mortality was observed in Piedmont during the 2019/2020 and 2020/2021 seasons, whereas mortality in subsequent seasons remained broadly in line with, or below, the expected values derived from the previous five years (Fig. S2-S6). In 2019/2020, excess mortality emerged from week 10 onwards and peaked in weeks 13 (+122%), 14 (+112%), and 15 (+102%). In 2020/2021, mortality also remained consistently above expected levels, with peaks in weeks 48 (+113%), 47 (+112%), and 46 (+106%). By contrast, excess mortality was modest in 2021/2022, with maximum weekly increases of 9%, and remained limited in 2022/2023 and 2023/2024, with peaks of 12% and 8%, respectively. Overall, excess mortality in Piedmont was highest in 2019/2020, remained elevated in 2020/2021, and progressively declined in subsequent seasons, a decline partially influenced by the increase in the expected number of deaths.

National trends broadly mirrored those observed in Piedmont, with marked excess mortality in 2019/2020 (peaking at +84% in week 13) and 2020/2021 (peaking at +54% in week 48). In later seasons, national excess

Fig. 3. Comparison of weekly ILI incidence in Italy and Piedmont. A) Average of the 2014/2015–2018/2019 seasons; B) 2019/2020 season; C) 2020/2021 season; D) 2021/2022 season; E) 2022/2023 season; F) 2023/2024 season.



mortality was substantially attenuated, with peak weekly increases ranging from 7% to 11%. Across seasons, excess mortality in Piedmont was generally more pronounced than the national average.

No significant correlation between observed deaths and ILI incidence was found in 2019/2020 (Spearman's rho=0.281, p=0.216) or 2020/2021 (rho=0.317, p = 0.171). In contrast, significant positive correlations were observed in 2021/2022 (rho=0.646, p=0.001), 2022/2023 (rho = 0.805, p<0.001), and 2023/2024 (rho = 0.947, p<0.001).

Vaccination coverage

Piedmont showed a slight improvement. In the older adults (aged 65+), coverage was consistently below 50% in the 2018/2019 season and earlier seasons, whereas since the 2019/2020 season it has remained slightly above 50%, with the highest coverage observed in the 2020/2021 season (65.3%). Similarly, coverage has improved in the total population: while it peaked at 15.3% before 2019/2020, it has been higher since that season, reaching 21.9% in 2020/2021. However, compared to Italy, over the last five years Piedmont has shown average coverage approximately 3 percentage points lower in the elderly population and about 1 percentage point lower in the total population. Considering the five seasons prior to our reference period, these differences with Italy have decreased for the elderly population but increased for the total population (Fig. 5; Fig. 6; Tab. S10).

From the 2019/2020 season, more detailed data on vaccination coverage are available for age groups under 65. For the pediatric population (up to 8 years of age), differences between Piedmont and Italy are more pronounced than those observed for the elderly and the total population. In Piedmont, the highest coverage rates are reported in the 2023/2024 season for children aged

Fig. 4. Distribution of influenza A and B viruses in Italy from the 2016/2017 to 2023/2024 seasons.

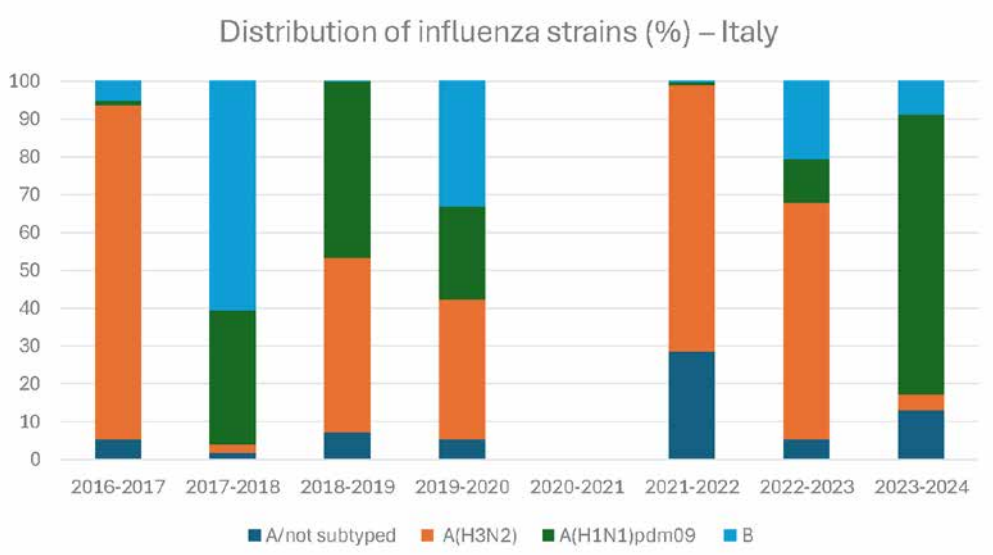
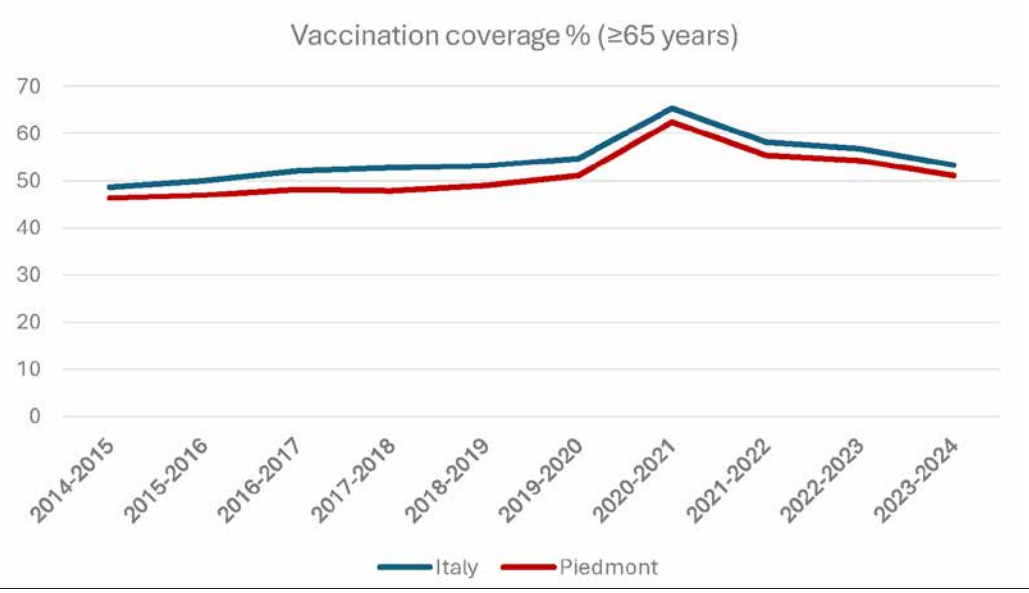


Fig. 5. Influenza vaccination coverage in the 65+ age group in Piedmont and Italy.



6-23 months (5.3%) and 2-4 years (9.5%), whereas for children aged 5-8 years, the highest coverage is observed in the 2022/2023 season (8.2%).

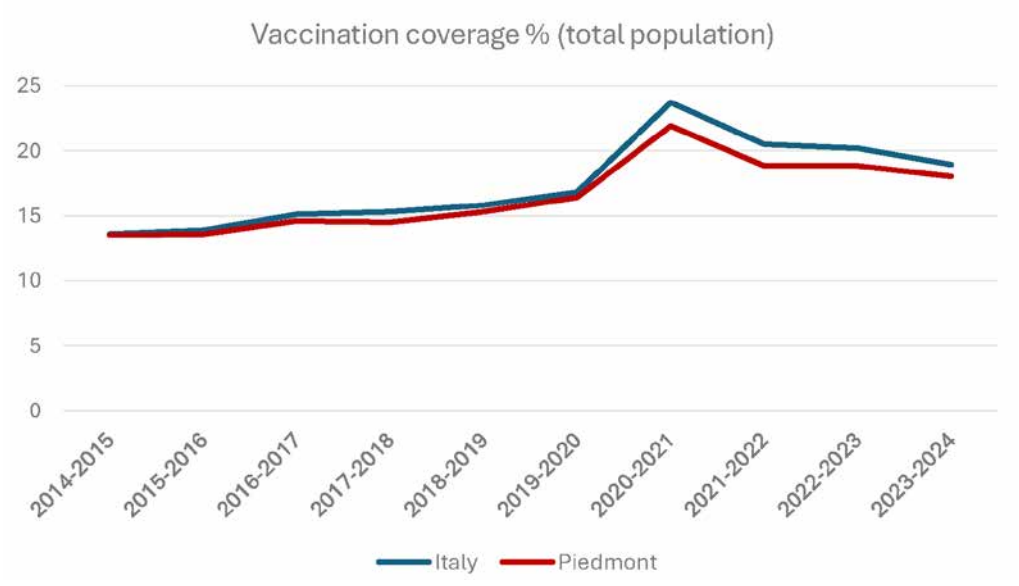
For the pre-adolescent/adolescent population (up to 17 years), differences between Piedmont and Italy are smaller, with the largest difference observed in children aged 9-14 years (-2.5 percentage points). In Piedmont, the highest coverage in the 2020/2021 season is among children aged 9–14 years (2.4%) and 15-17 years (1.7%).

In the adult population (up to 64 years of age), differences between Piedmont and Italy remain low, although a larger difference is observed in the 45-64 age group (-2.6 percentage points). In Piedmont, the highest coverage in the 2020/2021 season is among adults aged 18-44 years (3.9%) and 45-64 years (13.5%) (Tab. II).

Last, the PASSI and PASSI d'Argento surveillance systems provide an opportunity to evaluate influenza vaccination coverage in the adult population, both with and without chronic diseases. Considering the population aged 18-64 years (Tab. S11) and the population aged 65 years and over (Tab. S12), data from Piedmont from 2016-2019 to 2022/2023 generally show improvement, although the Region consistently reports lower coverage than Italy (the only exception being adults aged ≥65 years with at least one chronic disease in 2016-2019).

Regarding the most recent data (2022-2023), individuals with chronic diseases show higher coverage than those without chronic conditions in both age groups, with a larger difference observed in the 18-64 age group. Coverage among people aged 18-64 with chronic conditions remains very low (20.5%). In the 65+ age group, coverage improves, although still below the recommended target, with 59% vaccinated overall (64% when considering only those with at least one chronic disease).

Fig. 6. Influenza vaccination coverage in the total population in Piedmont and Italy.



Tab. II. Influenza vaccination coverage in Piedmont and Italy by age group (% of population).

Influenza vaccination: vaccination coverage %														
	6-23 months		2-4 years		5-8 years		9-14 years		15-17 years		18-44 years		45-64 years	
Season	**It.**	**Pi.**	**It.**	**Pi.**	**It.**	**Pi.**	**It.**	**Pi.**	**It.**	**Pi.**	**It.**	**Pi.**	**It.**	**Pi.**
2019-2020	2.8	0.8	4.2	1.5	3.1	1.2	1.9	1	1.9	1	3.1	2.5	9.6	8
2020-2021	9.2	2	19	3.8	13.1	3.4	6	2.4	4.5	1.7	5.9	3.9	16.8	13.5
2021-2022	7	3	17.4	6.5	12.2	4	4.4	1.9	2.5	1	4.2	2.6	13.7	10.1
2022-2023	7.2	3.1	9.2	3.6	22.6	8.2	4.9	1.8	2.1	1	4.1	2.7	13.3	10.5
2023-2024	9.8	5.3	16.7	9.5	11.7	5.8	4.6	2.1	1.9	1.1	3.7	2.9	11.8	9.9
Average	**7.2**	**2.8**	**13.3**	**5.0**	**12.5**	**4.5**	**4.4**	**1.8**	**2.6**	**1.2**	**4.2**	**2.9**	**13.0**	**10.4**

It. Italy; Pi. Piedmont

Discussion

This study examined influenza-related indicators in Piedmont over five influenza seasons, in a regional context characterized by persistently low vaccination coverage. By comparing regional findings with national data, it also sought to place the Piedmont experience within a broader public health perspective and to inform reflections on current prevention strategies.

The cumulative incidence of ILI in Piedmont increased overall during the observation period. Compared with national data, Piedmont consistently reported higher incidence rates than the Italian average, a difference that may reflect demographic characteristics, differences in the implementation of preventive measures, and seasonal variability in influenza circulation. A marked reduction in incidence was observed during the 2020/2021 season, followed by a sharp increase in 2022/2023 and 2023/2024. This pattern is consistent with the findings of Bert et al. [21], who suggested that the exceptionally low influenza circulation observed in 2020/2021 was mainly driven by COVID-19 containment measures rather than by reduced surveillance or increased vaccination coverage. The absence of laboratory-confirmed influenza cases in sentinel samples during the same season further supports the impact of these measures on influenza transmission. Although younger age groups continued to show the highest incidence rates, the gap between age groups progressively narrowed over time, suggesting a redistribution of disease burden. In particular, adults and older adults recorded a greater absolute number of estimated cases than children aged <14 years, a pattern that may reflect post-pandemic changes in exposure and transmission dynamics. In addition, the earlier onset and longer duration of seasonal peaks observed in recent years suggest a shift in the epidemiological pattern of ILI. Peak incidence in children aged <4 years generally preceded that in older adults, supporting the hypothesis that the paediatric population plays a central role in influenza transmission [12]. Owing to their high incidence and earlier involvement in seasonal epidemics, children likely represent an important source of transmission to more vulnerable groups, including older adults and individuals with chronic conditions [22]. Although influenza is usually self-limiting in children, the high number of infections in this group contributes

substantially to hospitalizations, school absenteeism, and healthcare utilization [23]. Conversely, while incidence rates in older adults remained lower than in children, the absolute number of cases was substantial and increasing, which is particularly relevant given their higher risk of severe complications, hospitalization, and death due to age-related vulnerability and comorbidities [24]. Together, these findings reinforce the need for effective prevention strategies, particularly for more vulnerable population groups.

Virological surveillance showed considerable variability in the circulation of influenza virus strains across seasons. The 2019/2020 and 2022/2023 seasons were characterized by the co-circulation of influenza A and B viruses, with both strains detected during most surveillance weeks. By contrast, influenza B was not detected in 2021/2022 and was only sporadically identified in 2023/2024, suggesting changes in strain circulation patterns. These findings are consistent with national and global data, which also indicate a predominance of influenza A in most seasons, with the notable exception of 2017/2018 [25, 26]. This pattern underscores the importance of continuous virological surveillance to inform vaccine composition and support prevention strategies. At the global level, the absence of detection of the B/Yamagata lineage since March 2020 has led the EMA to recommend removal of the B/Yamagata component from seasonal influenza vaccines, supporting the transition from quadrivalent to trivalent formulations from the 2025/2026 season onwards [27, 28]. In addition, national data showed a lower number of influenza-positive samples compared with pre-pandemic seasons. Taken together, these findings support the value of integrated surveillance systems, such as RespiVirNet, and suggest that broader prevention strategies targeting respiratory viruses beyond influenza alone may provide more effective long-term control.

Excess mortality in Piedmont was generally more pronounced than at the national level, suggesting regional disparities that warrant further investigation. Across the study period, excess mortality fluctuated markedly, peaking in 2019/2020 and progressively declining thereafter. This pattern may partly reflect the concurrent increase in expected mortality, which reduced the relative magnitude of observed deviations. Although excess mortality estimated in this way cannot be attributed to specific causes, COVID-19, influenza, and RSV likely represented major contributors, with their impact shaped by pathogen virulence, population immunity, and the age distribution of affected individuals [29]. In this regard, the return of winter mortality in Europe to pre-pandemic levels in 2023/2024, following several years of atypical patterns, provides an important broader context [29]. As noted by Nørgaard et al. [29], continuous mortality surveillance remains essential for monitoring epidemic trends and enabling timely public health responses. However, because excess mortality provides only a partial measure of disease burden, it should be interpreted alongside other indicators to achieve a more comprehensive assessment of overall impact.

Although influenza vaccination coverage in Piedmont improved over the five-year observation period compared with the pre-pandemic period, it remained well below national targets [7]. Among adults aged ≥65 years, coverage increased from below 50% before the 2018/2019 season to a peak of 65.3% in 2020/2021, but still remained approximately 3 percentage points lower than the national average. Coverage also increased in the general population, reaching 21.9% in 2020/2021, possibly reflecting greater public awareness during the COVID-19 pandemic. Nevertheless, vaccination uptake in Piedmont remained consistently lower than the national average across all age groups, with the largest gap observed among children aged <8 years, suggesting difficulties in fully implementing recent national vaccination policy updates. In recent years, recommendations from the Italian Ministry of Health on influenza prevention and control have progressively expanded eligibility for free and actively offered vaccination. Since 2019/2020, newly included groups have comprised pregnant women, individuals at increased risk, long-term care facility residents, blood donors, and caregivers [30]. In 2020/2021, postpartum women and adults aged 60-64 years were also included [31], while in 2022/2023 eligibility was further extended to children aged 6 months to 6 years [32]. The National Vaccination Prevention Plan 2023-2025 [PNPV] further reinforces the importance of reaching both traditional and newly identified target groups, highlighting the need for regional strategies to align more closely with national recommendations [7]. A further area of concern is the persistently low vaccination coverage among individuals with chronic conditions. Although coverage in these groups was higher than among people without comorbidities, it remained below both the national average for individuals with chronic diseases and the recommended target for high-risk populations [7]. Overall, while the increase in vaccination coverage observed in Piedmont is encouraging, additional efforts are still needed to meet public health objectives.

The lower influenza vaccination coverage observed in Piedmont compared with the Italian average is likely to reflect a combination of supply-side and demand-side factors. On the supply side, Italian evidence suggests that GP workload may impair influenza vaccination uptake among older adults, possibly by reducing opportunities for counselling, active recommendation, and timely vaccine delivery [33]. On the demand side, the OBVIOUS project showed that influenza vaccine uptake is strongly influenced by awareness of being in a priority group, social influence, and recommendations from GPs [34]. In addition, recent national evidence indicates that vaccine hesitancy remains highly prevalent in Italy and is shaped by multiple social, cultural, informational, and trust-related factors [35]. A higher prevalence of vaccine hesitancy was described in Northern Italy rather than in Southern Italy [35], a finding that is consistent with a possible demand-side contribution to lower uptake in Piedmont. This suggests that the lower coverage

observed in Piedmont should not be interpreted solely as a marker of structural disadvantage, particularly because broader territorial inequalities in Italy have historically been more pronounced in Southern and peripheral areas [36]. Rather, suboptimal coverage may reflect a complex interplay between primary-care organization, active invitation practices, risk perception, trust, and local patterns of vaccine confidence that should be further investigated.

Although centred on Piedmont, this study highlights issues that are likely to be relevant in other regional and national contexts. The observed post-pandemic reshaping of ILI patterns, the growing contribution of adult and older populations to overall burden, and the persistent gap between vaccination recommendations and vaccine uptake suggest that influenza prevention should be supported by both adaptable immunisation strategies and integrated surveillance systems. Targeted strategies are essential to reduce the burden of seasonal influenza and improve vaccination coverage. Although social distancing measures have proven effective, their sustainability during influenza seasons is likely to be limited, as noted by Fricke et al. [37]. Evidence from previous studies indicates that vaccine uptake can be improved through interventions such as written reminders, home visits, personalised phone calls, and educational initiatives, as reported in the meta-analysis by Thomas and Lorenzetti [38]. Strategies that reduce access barriers, including free vaccination and delivery in non-traditional settings such as hospital outpatient clinics, nursing homes, pharmacies, and mobile units, have also shown value in increasing coverage among at-risk populations [39]. Likewise, incentives for healthcare professionals and personalised approaches, including individual counselling and targeted public health campaigns, may help strengthen uptake, especially among older adults and high-risk groups [40]. Further research is nevertheless required to adapt and validate these interventions within the local context and to assess their long-term sustainability and effectiveness.

This study had several limitations that should be acknowledged. First, the analysis was constrained by incomplete data availability, particularly at the regional level in Piedmont, which limited its comprehensiveness. Moreover, no additional indicators of disease burden were accessible, which could have provided a more holistic understanding of influenza impact. Most data analysed derive from the ILI surveillance system rather than laboratory-confirmed influenza cases. While ILI is a useful proxy for estimating influenza trends, its accuracy may be affected by the co-circulation of other respiratory viruses. Lastly, because influenza-specific mortality data were not available, we used excess all-cause mortality as an indirect proxy for influenza-associated mortality; however, this measure is not specific to influenza and may have been substantially confounded by SARS-CoV-2 circulation during the COVID-19 pandemic.

Conclusion

This study provides a comprehensive overview of influenza-related indicators in Piedmont across five influenza seasons. Overall, Piedmont showed a higher ILI incidence than the Italian average, together with a progressive narrowing of the gap between paediatric and adult/older age groups, suggesting a redistribution of disease burden towards older populations. Virological findings further support the need for an integrated approach to the surveillance and prevention of respiratory infections beyond influenza alone, while the excess mortality results highlight the importance of combining multiple indicators to better capture seasonal burden. Although vaccination coverage improved compared with the pre-pandemic period, it remained below national targets across key population groups. Beyond the regional setting, these findings suggest that post-pandemic influenza prevention requires adaptable vaccination strategies, closer alignment between national recommendations and local implementation, and integrated surveillance systems capable of monitoring changing epidemiological patterns and informing timely public health action.

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Ethical approval

Not applicable.

Conflict of interest statement

The Authors declare that there is no conflict of interest.

Authors' contributions

RS: Conceptualization; GLM: Methodology; GLM, FG, DC, SM: Formal analysis; GLM, FG, DC, SM: Data curation; GLM, FG, DC, SM: Writing-Original Draft; GLM, RS: Writing-Review & Editing; GLM, FG, DC, SM: Visualization; RS: Supervision; GLM, RS: Project Administration; RS: Funding acquisition.

References

[1] Paget J, Staadegaard L, Wang X, Li Y, van Pomeren T, van Summeren J, Dückers M, Chaves SS, Johnson EK, Mahé C, Nair H, Viboud C, Spreeuwenberg P. Global and national influenza-associated hospitalisation rates: Estimates for 40 countries and

administrative regions. J Glob Health 2023;13:04003. https://doi.org/10.7189/jogh.13.04003.

[2] Macias AE, McElhaney JE, Chaves SS, Nealon J, Nunes MC, Samson SI, Seet BT, Weinke T, Yu H. The disease burden of influenza beyond respiratory illness. Vaccine 2021;39(Suppl 1):A6-A14. https://doi.org/10.1016/j.vaccine.2020.09.048.

[3] Trentini F, Pariani E, Bella A, Diurno G, Crottogini L, Rizzo C, Merler S, Ajelli M. Characterizing the transmission patterns of seasonal influenza in Italy: lessons from the last decade. BMC Public Health 2022;22:19. https://doi.org/10.1186/s12889-021-12426-9.

[4] Giacchetta I, Primieri C, Cavalieri R, Domnich A, de Waure C. The burden of seasonal influenza in Italy: A systematic review of influenza-related complications, hospitalizations, and mortality. Influenza Other Respir Viruses 2022;16:351-65. https://doi.org/10.1111/irv.12925.

[5] Guo J, Chen X, Guo Y, Liu M, Li P, Tao Y, Liu Z, Yang Z, Zhan S, Sun F. Real-world effectiveness of seasonal influenza vaccination and age as effect modifier: A systematic review, meta-analysis and meta-regression of test-negative design studies. Vaccine 2024;42:1883-91. https://doi.org/10.1016/j.vaccine.2024.02.059.

[6] Addario A, Célarier T, Bongue B, Barth N, Gavazzi G, Botelho-Nevers E. Impact of influenza, herpes zoster, and pneumococcal vaccinations on the incidence of cardiovascular events in subjects aged over 65 years: a systematic review. Geroscience 2023;45:3419-47. https://doi.org/10.1007/s11357-023-00807-4.

[7] Presidenza del Consiglio dei Ministri Conferenza permanente per i rapporti tra lo stato le regioni e le province autonome. Intesa, ai sensi dell'articolo 8, comma 6, della legge 5 giugno 2003, n. 131, tra il Governo, le regioni e le Province autonome di Trento e di Bolzano, sul documento recante «Piano nazionale di prevenzione vaccinale (PNPV) 2023-2025» e sul documento recante «Calendario nazionale vaccinale» (Rep. atti n. 193/CSR del 2 agosto 2023) (23A04685).

[8] Epicentro. Coperture della vaccinazione antinfluenzale in Italia. Available at: https://www.epicentro.iss.it/influenza/coperture-vaccinali. Accessed on: 05/01/2025.

[9] RespiVirNet - Sorveglianza integrata dei virus respiratori. Available at: https://respivirnet.iss.it/default.aspx?ReturnUrl=%2f. Accessed on: 05/01/2025.

[10] RespiVirNet - Protocollo Operativo Stagione 2024-2025. Available at: https://respivirnet.iss.it/pagine/Documenti.aspx (Last access: 5 Jan 2025). Accessed on: 05/01/2025.

[11] InfluNet & CovidNet - Protocollo Operativo Sorveglianza epidemiologica e virologica dei casi di sindrome simil-influenzale, di influenza e SARS-CoV-2 Stagione 2020/2021. Available at: https://www.salute.gov.it/imgs/C_17_pubblicazioni_2963_allegato.pdf. Accessed on: 05/01/2025.

[12] Boccalini S, Bechini A. Assessment of Epidemiological Trend of Influenza-Like Illness in Italy from 2010/2011 to 2023/2024 Season: Key Points to Optimize Future Vaccination Strategies against Influenza. Vaccines (Basel) 2024;12:841. https://doi.org/10.3390/vaccines12080841.

[13] FluNews/RespiNews-Italia: archivio. Available at: https://www.epicentro.iss.it/influenza/FluNewsArchivio. Accessed on: 05/01/2025.

[14] Epicentro. Mortalità per influenza. Available at: https://www.epicentro.iss.it/influenza/sorveglianza-mortalita-influenza. Accessed on: 05/01/2025.

[15] ISTAT. Decessi e cause di morte: cosa produce l'Istat. Available at: https://www.istat.it/notizia/dati-di-mortalita-cosa-produce-listat/. Accessed on: 05/01/2025.

[16] Epicentro. RespiNews – Italia. Rapporto della sorveglianza integrata dei virus respiratori. Principi metodologici. Available at: https://www.epicentro.iss.it/influenza/pdf/RespiNews-metodologia.pdf. Accessed on: 05/01/2025.

[17] ISTAT. Demografia in cifre. Available at: https://demo.istat.it/?l=it. Accessed on: 05/01/2025.

[18] Ministero della Salute. vaccinazione antinfluenzale - Coperture vaccinali medie. Available at: https://www.salute.gov.it/portale/documentazione/p6_2_8_1_1.jsp?lingua=italiano&id=37. Accessed on: 05/01/2025.

[19] Epicentro. PASSI. I dati per l'Italia: vaccinazione antinfluenzale. Available at: https://www.epicentro.iss.it/passi/dati/vaccinazioneantinfluenzale#dati. Accessed on: 05/01/2025.

[20] Epicentro. Passi d'Argento. I dati per l'Italia: vaccinazione antinfluenzale. Available at: https://www.epicentro.iss.it/passi-argento/dati/vaccinazioneantinfluenzale#dati. Accessed on: 05/01/2025.

[21] Bert F, Cugudda E, Lo Moro G, Galvagno PF, Siliquini R. Exploring the drop in flu cases during the 2020-2021 season: The Italian case study. Ann Epidemiol 2022;76:77-82. https://doi.org/10.1016/j.annepidem.2022.10.001.

[22] Nayak J, Hoy G, Gordon A. Influenza in Children. Cold Spring Harb Perspect Med 2021;11:a038430. https://doi.org/10.1101/cshperspect.a038430.

[23] Antonova EN, Rycroft CE, Ambrose CS, Heikkinen T, Principi N. Burden of paediatric influenza in Western Europe: a systematic review. BMC Public Health 2012;12:968. https://doi.org/10.1186/1471-2458-12-968.

[24] Paules C, Subbarao K. Influenza. Lancet 2017;390:697-708. https://doi.org/10.1016/S0140-6736(17)30129-0.

[25] Zheng L, Lin Y, Yang J, Fang K, Wu J, Zheng M. Global variability of influenza activity and virus subtype circulation from 2011 to 2023. BMJ Open Respir Res 2023;10:e001638. https://doi.org/10.1136/bmjresp-2023-001638.

[26] Lu C, Barr IG, Lambert S, Mengersen K, Wang L, Yang W, Li Z, Vardoulakis S, Bambrick H, Hu W. Shifts in seasonal influenza patterns in Australia during and after COVID-19: A comprehensive analysis. J Infect Public Health 2025;18:102620. https://doi.org/10.1016/j.jiph.2024.102620.

[27] World Health Organization. Recommended Composition of Influenza Virus Vaccines for Use in the 2024–2025 Northern Hemisphere Influenza Season February 2024. Available at: https://www.who.int/publications/m/item/recommended-composition-of-influenza-virus-vaccines-for-use-in-the-2023-2024-northern-hemisphere-influenza-season. Accessed on: 05/01/2025.

[28] European Medicines Agency. EU recommendations for 2024/2025 seasonal flu vaccine composition (26 March 2024). Available at: https://www.ema.europa.eu/en/news/eu-recommendations-2024-2025-seasonal-flu-vaccine-composition. Accessed on: 05/01/2025.

[29] Nørgaard SK, Nielsen J, Nordholm AC, Richter L, Chalupka A, Sierra NB, Braeye T, Athanasiadou M, Lytras T, Denissov G, Luomala O, Fouillet A, Pontais I, An der Heiden M, Zacher B, Weigel A, Foppa I, Gkolfinopoulou K, Panagoulias I, Paldy A, Malnasi T, Domegan L, Kelly E, Rotem N, Rakhlin O, de'Donato FK, Di Blasi C, Hoffmann P, Velez T, England K, Calleja N, van Asten L, Jongenotter F, Rodrigues AP, Silva S, Klepac P, Gomez-Barroso D, Gomez IL, Galanis I, Farah A, Weitkunat R, Fehst K, Andrews N, Clare T, Bradley DT, O'Doherty MG, William N, Hamilton M, Søborg B, Krause TG, Bundle N, Vestergaard LS. Excess mortality in Europe coincides with peaks of COVID-19, influenza and respiratory syncytial virus (RSV), November 2023 to February 2024. Euro Surveill 2024;29:2400178. https://doi.org/10.2807/1560-7917.ES.2024.29.

[30] Ministero della salute. Prevenzione e controllo dell'influenza: raccomandazioni per la stagione 2019/2020. Available at: https://www.trovanorme.salute.gov.it/norme/renderNormsanPdf?anno=2019&codLeg=70621&parte=1%20&serie=null. Accessed on: 05/01/2025.

[31] Ministero della salute. Prevenzione e controllo dell'influenza: raccomandazioni per la stagione 2020/2021. Available at: https://www.trovanorme.salute.gov.it/norme/renderNormsanP

df?anno=2020&codLeg=74451&parte=1%20&serie=null. Accessed on: 05/01/2025.

[32] Ministero della salute. Prevenzione e controllo dell'influenza: raccomandazioni per la stagione 2022/2023. Availble at: https://www.trovanorme.salute.gov.it/norme/renderNormsanPdf?anno=2022&codLeg=87997&parte=1%20&serie=null. Accessed on: 05/01/2025.

[33] Domnich A, Lapi F, Orsi A, Grattagliano I, Rossi A, Cricelli C, Icardi G. Declining number of general practitioners can impair influenza vaccination uptake among Italian older adults: Results from a panel analysis. BMC Health Serv Res 2024;24:950. https://doi.org/10.1186/s12913-024-11443-9.

[34] Capodici A, Montalti M, Soldà G, Salussolia A, La Fauci G, Di Valerio Z, Scognamiglio F, Fantini MP, Odone A, Costantino C, Larson HJ, Leask J, Lenzi J, Gori D; OBVIOUS Board; Observatory on Vaccine Hesitancy in Italy - Online UniBo Surveys. Influenza vaccination landscape in Italy: A comprehensive study through the OBVIOUS project lens. Hum Vaccin Immunother 2023;19:2252250. https://doi.org/10.1080/21645515.2023.2252250.

[35] Lo Moro G, Bert F, Calabrò GE, Carta MG, Cossu G, De Vito C, Martella M, Massimi A, Odone A, Ragusa P, Vigezzi GP, Ricciardi W, Siliquini R. Prevalence of vaccine hesitancy in Italy: a cross-sectional study. Lancet Reg Health Eur 2026;63:101603. https://doi.org/10.1016/j.lanepe.2026.101603.

[36] Pastorelli E, Stocchiero A. Inequalities in Italy. 2019. Available at: https://www.sdgwatcheurope.org/wp-content/uploads/2019/06/8.3.a-report-IT.pdf. Accessed on: 05/01/2025.

[37] Fricke LM, Glöckner S, Dreier M, Lange B. Impact of non-pharmaceutical interventions targeted at COVID-19 pandemic on influenza burden - a systematic review. J Infect 2021;82:1-35. https://doi.org/10.1016/j.jinf.2020.11.039.

[38] Thomas RE, Lorenzetti DL. Interventions to increase influenza vaccination rates of those 60 years and older in the community. Cochrane Database Syst Rev 2018;5:CD005188. https://doi.org/10.1002/14651858.CD005188.pub4.

[39] Calabrò GE, Tognetto A, Carini E, Mancinelli S, Sarnari L, Colamesta V, Ricciardi W, de Waure C. Strategies to Improve Vaccination among At-Risk Adults and the Elderly in Italy. Vaccines (Basel) 2020;8:358. https://doi.org/10.3390/vaccines8030358.

[40] Eiden AL, Barratt J, Nyaku MK. A review of factors influencing vaccination policies and programs for older adults globally. Hum Vaccin Immunother 2023;19:2157164. https://doi.org/10.1080/21645515.2022.2157164.

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Supplementary material

Tab. S1. Missing data on weekly Influenza-like Illness (ILI) incidence.

Piedmont	**MISSING**
season	**week**
2014-2015	43
	44
	45
2015-2016	42
	43
	17
2016-2017	42
	43
2017-2018	42
	43
2018-2019	42
2019-2020	42
	43
	11
	12
	13
	15
	16
2020-2021	42
	43
	44
	45
	46
	47
	48
	13
	17
2021-2022	7
	8
	42
	43
2022-2023	42
	15
2023-2024	42
	43
	44
Italy	**MISSING**
season	**week**
2015-2016	17
2020-2021	17

Tab. S2. Cumulative ILI incidence (%) for the seasons 2014/2015 to 2023/2024, by age group in Piedmont.

Estimated cumulative incidence of ILI in Piedmont (%)					
Season	**0-4 years**	**5-14 years**	**15-64 years**	**≥65 years**	**Total Population**
2014-2015	47.9	25.5	13.4	5.9	13.7
2015-2016	43.9	25.2	9.5	4.2	11.4
2016-2017	55.3	20.5	13.0	6.8	13.7
2017-2018	65.3	24.8	15.3	7.3	15.6
2018-2019	63.9	23.2	14.0	5.7	14.5
Average 2014/2015-2018/2019	**55.2**	**23.8**	**13.0**	**6.0**	**13.8**
2019-2020	33.6	16.6	11.0	5.0	12.1
2020-2021	6.4	2.4	5.7	3.0	4.5
2021-2022	46.3	22.3	16.8	7.0	16.7
2022-2023	48.5	31.4	26.1	15.3	25.3
2023-2024	34.9	19.6	24.6	13.6	21.6
Average 2019/2020-2023/2024	**33.9**	**18.5**	**16.8**	**8.8**	**16.0**

Tab. S3. Cumulative ILI incidence (%) for the seasons 2014/2015 to 2023/2024, by age group in Italy.

Estimated cumulative incidence of ILI in Italy (%) *(estimates including only the weeks for which data were also available for Piedmont)*					
Season	**0-4 years**	**5-14 years**	**15-64 years**	**≥65 years**	**Total Population**
2014-2015	24.6 (24.1)	16.8 (16.6)	9.6 (9.4)	4.5 (4.4)	10.3 (10.1)
2015-2016	22.1 (21.9)	16 (15.9)	6.9 (6.8)	2.8 (2.8)	8 (7.9)
2016-2017	22 (21.7)	12.7 (12.5)	8.4 (8.3)	4.9 (4.8)	9 (8.8)
2017-2018	37.7 (37.2)	20.7 (20.5)	13.2 (13)	7.4 (7.3)	14.3 (14.1)
2018-2019	36.6 (36.4)	19.3 (19.3)	12.6 (12.5)	6.1 (6.1)	13.4 (13.3)
Average 2014/2015-2018/2019	**28.6 (28.3)**	**17.1 (17)**	**10.1 (10)**	**5.1 (5.1)**	**11 (10.9)**
2019-2020	31.8 (30.2)	19.9 (19.1)	11.8 (10.4)	5.5 (4.7)	12.6 (11.4)
2020-2021	7.5 (5.8)	3.5 (2.6)	4.3 (2.8)	2.8 (1.8)	4 (2.7)
2021-2022	32.4 (28.6)	13.5 (12.2)	10.6 (9.6)	5.6 (5)	11 (10)
2022-2023	69.7 (67.2)	34.3 (33.2)	21.8 (20.9)	12.1 (11.6)	23.7 (22.8)
2023-2024	61.8 (58.8)	26.8 (25.5)	24.8 (23.1)	14.8 (13.7)	24.8 (23.2)
Average 2019/2020-2023/2024	***40.7 (38.1)***	***19.6 (18.5)***	***14.7 (13.4)***	***8.1 (7.4)***	***15.2 (14)***

Tab. S4. Maximum weekly incidence of ILI in Piedmont for the 2014/2015 to 2023/2024 seasons. The week of each peak is indicated in parentheses.

Maximum weekly incidence of ILI (‰) in Piedmont (week)					
Season	**0-4 years**	**5-14 years**	**15-64 years**	**≥65 years**	**Total Population**
2014-2015	51.8 (6)	31.3 (6)	15.1 (6)	5.9 (7)	14.9 (5)
2015-2016	38.3 (weeks 5 and 6)	29.9 (8)	8.1 (7)	3.1 (11)	10 (7)
2016-2017	54.3 (3)	21.4 (51)	13.6 (1)	8.7 (1)	13.1 (1)
2017-2018	65.2 (4)	29.9 (52)	19.5 (1)	12.7 (1)	18.1 (1)
2018-2019	54.5 (7)	26.4 (6)	13.3 (6)	6.5 (6)	14.5 (6)
Average 2014/2015-2018/2019	**52.8**	**27.8**	**13.9**	**7.4**	**14.1**
2019-2020	38.4 (7)	20.9 (8)	9.2 (5)	4.6 (5)	11.5 (7)
2020-2021	7.3 (4)	2.2 (5)	5.3 (49)	2.5 (9)	3.3 (49)
2021-2022	32.7 (47)	18.2 (12)	12.9 (2)	6.2 (1)	10.9 (2)
2022-2023	47.8 (50)	34.6 (49)	20.9 (50)	12 (50)	21.3 (50)
2023-2024	41.7 (51)	22 (51)	17.4 (50)	11.5 (1)	16.4 (51)
Average 2019/2020-2023/2024	**33.6**	**19.6**	**13.1**	**7.3**	**12.7**

Tab. S5. Weeks of onset, peak, and end, and duration of the epidemic period for the 2014/2015 to 2023/2024 seasons in Piedmont.

Season	Beginning	Peak	End	Duration (weeks)
2014-2015	46	5	15	22
2015-2016	50	7	15	19
2016-2017	44	1	13	22
2017-2018	46	1	16	23
2018-2019	45	6	15	23
Average 2014/2015-2018/2019	**46**	**-**	**15**	**22**
2019-2020	44	7	10	19
2020-2021	49	49	11	16
2021-2022	44	2	17	26
2022-2023	43	50	17	27
2023-2024	45	51	17	25
Average 2019/2020-2023/2024	**45**	**-**	**14**	**23**

Tab. S6. Weeks of onset, peak, and end, and duration of the epidemic period for the 2014/2015 to 2023/2024 seasons in Italy.

Season	Beginning	Peak	End	Duration (weeks)
2014-2015	51	4	13	15
2015-2016	52	8	14	16
2016-2017	48	52	9	14
2017-2018	48	2	12	17
2018-2019	47	5	13	19
Average 2014/2015-2018/2019	**49**	**-**	**12**	**16**
2019-2020	46	5	12	19
2020-2021	45	45	45	1
2021-2022	42	13	17	28
2022-2023	42	48	17	28
2023-2024	42	52	17	28
Average 2019/2020-2023/2024	**43**	**-**	**10**	**21**

Tab. S7. Number of weeks per season in which each influenza strain was detected - Piedmont.

Season	Number of weeks with samples submitted	Number of weeks in which each strain was detected (% of weeks with samples sent)			
		A/not subtyped	A(H3N2)	A(H1N1)pdm09	B
2016-2017	22	2 (9.1)	10 (45.5)	4 (18.2)	3 (13.6)
2017-2018	18	3 (16.7)	0 (0)	15 (83.3)	8 (44.4)
2018-2019	21	15 (71.4)	10 (47.6)	15 (71.4)	0 (0)
2019-2020	15	10 (66.7)	4 (26.7)	5 (33.3)	9 (60)
2020-2021	22	0 (0)	0 (0)	0 (0)	0 (0)
2021-2022	24	9 (37.5)	13 (54.2)	0 (0)	0 (0)
2022-2023	22	16 (72.7)	10 (45.5)	12 (54.5)	15 (68.2)
2023-2024	21	12 (57.1)	4 (19)	11 (52.4)	3 (14.3)

Tab. S8. Number of weeks per season in which each influenza strain was detected - Italy.

Season	Number of weeks with samples submitted	Number of weeks in which each strain was detected (% of weeks with samples sent)			
		A/not subtyped	A(H3N2)	A(H1N1)pdm09	B
2016-2017	24	14 (58.3)	21 (87.5)	14 (58.3)	19 (79.2)
2017-2018	23	19 (82.6)	19 (82.6)	22 (95.7)	21 (91.3)
2018-2019	23	18 (78.3)	23 (100)	23 (100)	5 (21.7)
2019-2020	24	14 (58.3)	19 (79.2)	19 (79.2)	17 (70.8)
2020-2021	24	0 (0)	0 (0)	0 (0)	0 (0)
2021-2022	24	15 (62.5)	23 (95.8)	12 (50)	5 (20.8)
2022-2023	24	23 (95.8)	22 (91.7)	24 (100)	24 (100)
2023-2024	24	21 (87.5)	24 (100)	23 (95.8)	23 (95.8)

Tab. S9. Number of samples collected, influenza-positive samples, and positivity rate (%) – Italy.

Season	Total samples collected	Total influenza positive samples	Influenza positivity (%)
2016-2017	12,034	3,518	29.23
2017-2018	16,135	5,494	34.05
2018-2019	20,009	6,368	31.83
2019-2020	16,146	3,760	23.29
Average 2014/2015-2018/2019	**16,081**	**4,785**	**29.60**
2020-2021	6,818	0	0.00
2021-2022	13,063	1,899	14.54
2022-2023	28,977	6,325	21.83
2023-2024	59,662	7,985	13.38
Average 2019/2020-2023/2024	**27,130**	**4,052**	**12.44**

Tab. S10. Influenza vaccination coverage in Piedmont and Italy, and differences in percentage points (pp) for the total population and the 65+ age group.

	Influenza vaccination: vaccination coverage per 100 inhabitants					
	≥65 years			Total population		
Season	Italy	Piedmont	p.p.	Italy	Piedmont	p.p.
2014-2015	48.6	46.3	-2.3	13.6	13.5	-0.1
2015-2016	49.9	46.9	-3	13.9	13.6	-0.3
2016-2017	52	48.2	-3.8	15.1	14.6	-0.5
2017-2018	52.7	47.9	-4.8	15.3	14.5	-0.8
2018-2019	53.1	49	-4.1	15.8	15.3	-0.5
Average 2014/2015-2018/2019	**51.26**	**47.66**	**-3.6**	**14.74**	**14.3**	**-0.4**
2019-2020	54.6	51	-3.6	16.8	16.4	-0.4
2020-2021	65.3	62.4	-2.9	23.7	21.9	-1.8
2021-2022	58.1	55.4	-2.7	20.5	18.8	-1.7
2022-2023	56.7	54.2	-2.5	20.2	18.8	-1.4
2023-2024	53.3	51	-2.3	18.9	18	-0.9
Average 2019/2020-2023/2024	**57.6**	**54.8**	**-2.8**	**20.02**	**18.78**	**-1.2**

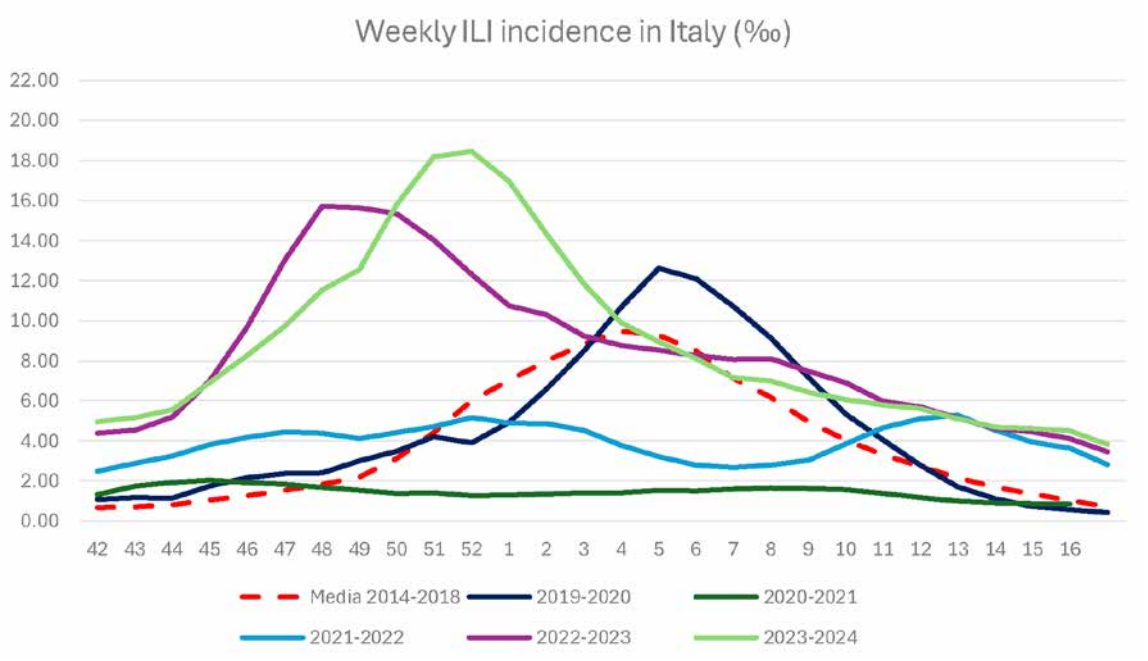
Tab. S11. Influenza vaccination coverage in Piedmont and Italy according to PASSI surveillance: adults aged 18–64 years with and without chronic diseases (%).

	Influenza vaccination coverage: Passi surveillance					
	18-64 years		18-64 years: with at least 1 chronic disease		18-64 years: without chronic disease	
Season	Italy	Piedmont	Italy	Piedmont	Italy	Piedmont
2016-2019	7.8	7	20.7	19.1	5.4	4.6
2020-2021	13.5	10.5	27.6	17.6	10.7	8.9
2021-2022	13.9	11.3	28.7	18.8	10.9	9.6
2022-2023	12.8	10.5	27.6	20.5	10	8.4

Table S12. Influenza vaccination coverage in Piedmont and Italy according to PASSI d'Argento surveillance: adults aged ≥65 years with and without chronic diseases (%).

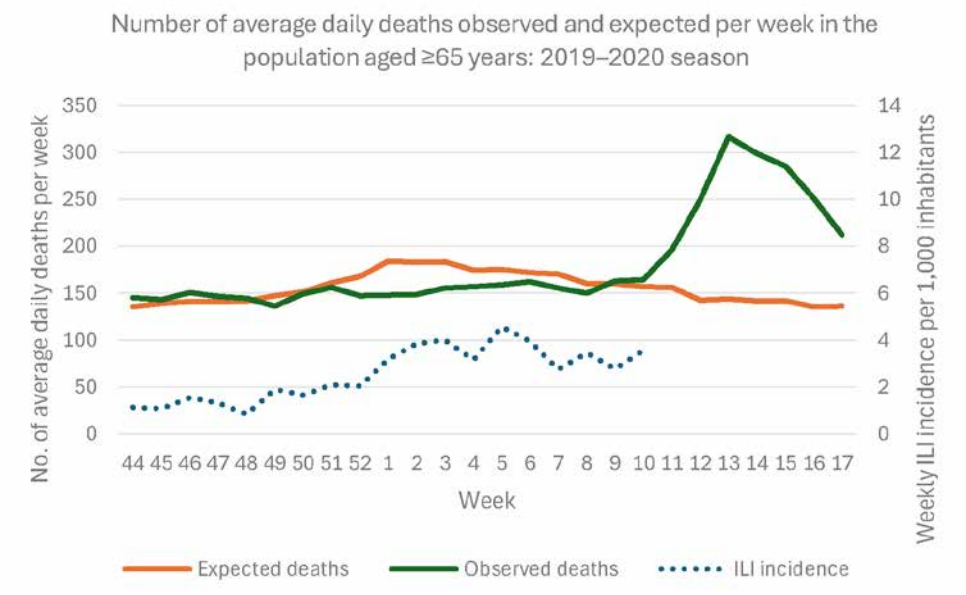
	Influenza vaccination coverage: Passi d'Argento surveillance					
	≥65 years		≥65 years: with at least 1 chronic disease		≥65 years: without chronic disease	
Season	Italy	Piedmont	Italy	Piedmont	Italy	Piedmont
2016-2019	56.4	53.4	62.9	64.3	46.3	42.7
2020-2021	68	-	72.7	-	61	-
2021-2022	68.2	-	72.8	-	61.8	-
2022-2023	65.3	59	71	63.6	57.4	53.6

Fig. S1. Weekly ILI incidence in Italy for the 2019/2020 to 2023/2024 seasons and for the average of the 2014/2015 to 2018/2019 seasons..



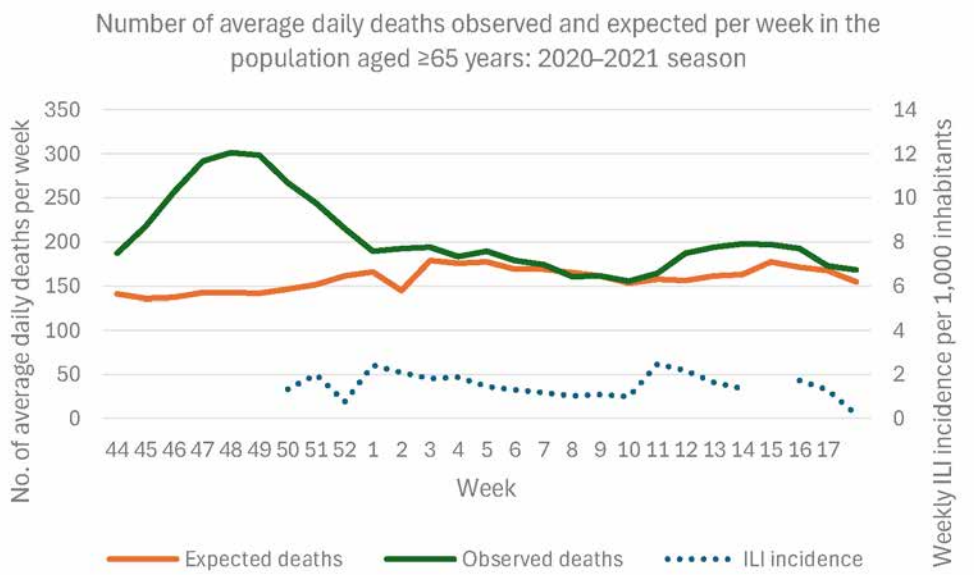
Week 53 was excluded, as it occurred only in the 2020/2021 season within our five-year reference period.

Fig. S2. Average daily number of observed and expected deaths per week in the population aged 65 and over in Piedmont during the 2019/2020 season.



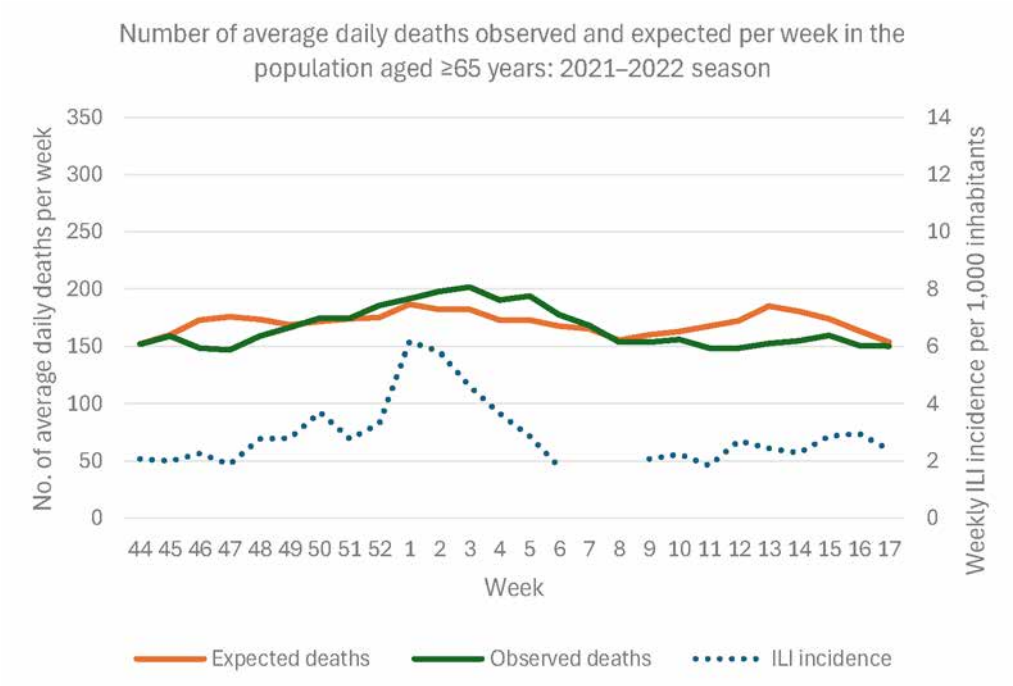
Expected deaths were estimated based on the 2014/2015–2018/2019 seasons. The incidence of ILI in the 65+ age group during the 2019/2020 season is also shown.

Fig. S3. Average daily number of observed and expected deaths per week in the population aged 65 and over in Piedmont during the 2020/2021 season.



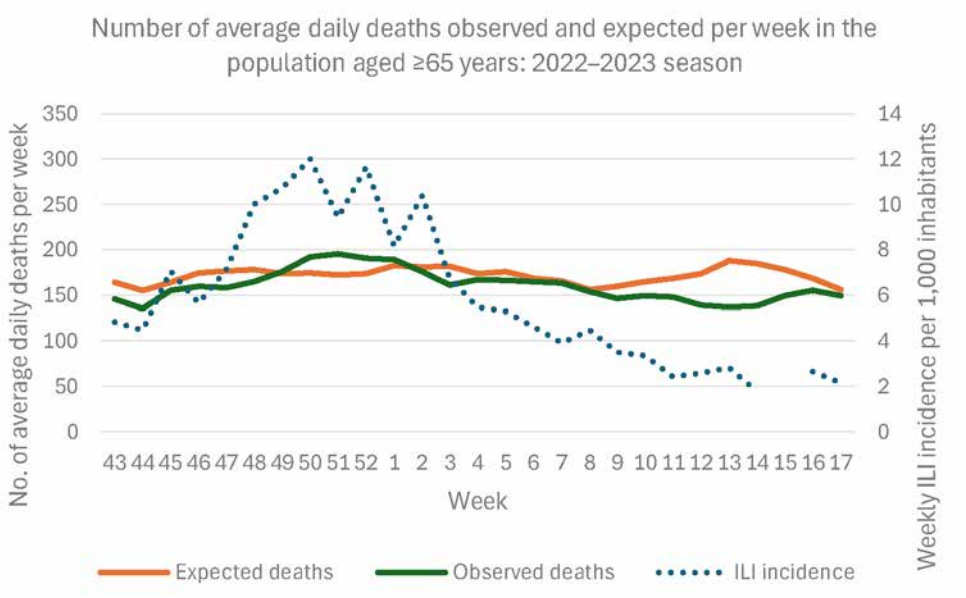
Expected deaths were estimated based on the 2015/2016–2019/2020 seasons. The incidence of ILI in the 65+ age group during the 2020/2021 season is also shown

Fig. S4. Average daily number of observed and expected deaths per week in the population aged 65 and over in Piedmont during the 2021/2022 season.



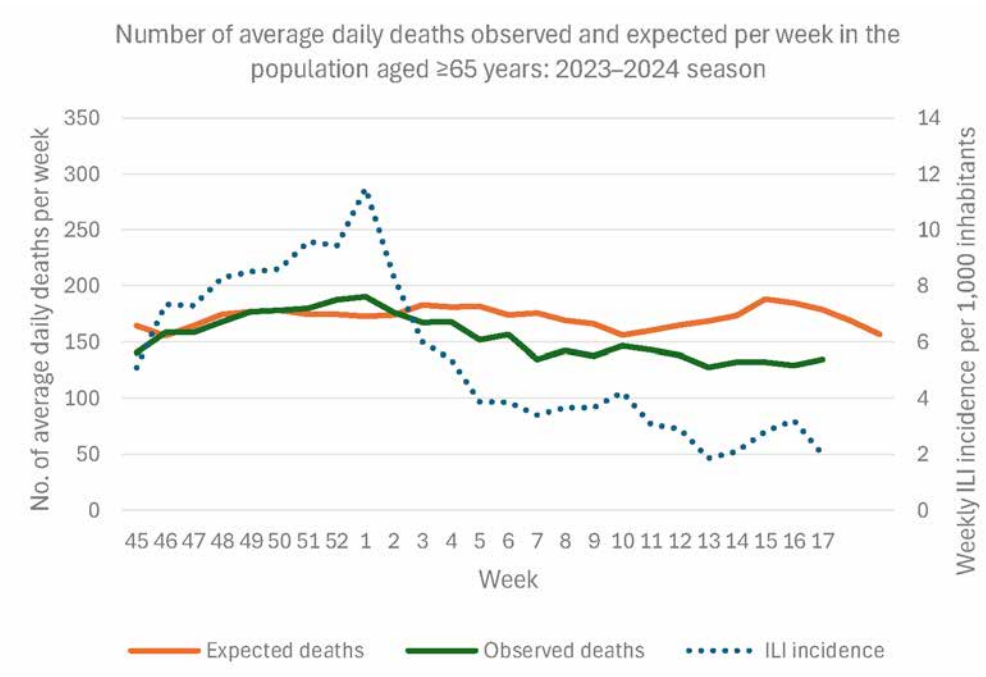
Expected deaths were estimated based on the 2016/2017–2020/2021 seasons. The incidence of ILI in the 65+ age group during the 2021/2022 season is also shown.

Fig. S5. Average daily number of observed and expected deaths per week in the population aged 65 and over in Piedmont during the 2022/2023 season.



Expected deaths were estimated based on the 2017/2018–2021/2022 seasons. The incidence of ILI in the 65+ age group during the 2022/2023 season is also shown.

Fig. S6. Average daily number of observed and expected deaths per week in the population aged 65 and over in Piedmont during the 2023/2024 season.



Expected deaths were estimated based on the 2018/2019–2022/2023 seasons. The incidence of ILI in the 65+ age group during the 2023/2024 season is also shown.

Infectious disease

Assessing influenza vaccination advocacy attitudes and recommendation behaviors among non-physician healthcare workers during the 2024-25 respiratory virus season

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Keywords

Influenza • Vaccine • MoVac • MoVad

Summary

Introduction. *Influenza is a highly contagious viral respiratory infection that spreads quickly in crowded and closed environments. Non-physician healthcare workers (HCW) play an essential role in vaccination discussions and initiatives in healthcare facilities. Our study aims to explore influenza vaccination acceptance and advocacy behavior among non-physician HCW during the 2024-25 respiratory virus season within a large healthcare system in Georgia, USA.*
Methods. *A cross-sectional survey was conducted using validated instruments, the Motors of influenza vaccination acceptance (MoVac-flu) and the Motors of engagement with vaccination advocacy (MovAd-flu). Data was collected via an online survey platform between February 4 and March 15, 2025.*
Results. *A total of 156 responses were received, with 141 included after data cleaning. Most participants were registered nurses (27.7%), aged 25-34 years (29.8%) and identified as female (84.4%). The average MoVac score was 5.31 (SD=1.43) and the average MovAd score was 4.7 (SD=1.27), both out of a maximum of 7. Linear regression analysis revealed a significant positive correlation between participants' comfort in discussing influenza vaccination with patients and their MoVac and MovAd scores. Clinical guidelines and recommendations emerged as strong motivators for initiating vaccination discussions.*
Conclusion. *Findings indicate that non-physician HCW demonstrate favorable attitudes toward influenza vaccination acceptance and advocacy, as reflected in consistently high MoVac and MovAd scores. These results suggest that non-physician healthcare workers may serve as effective messengers in promoting influenza vaccination within healthcare systems. Future initiatives could leverage their role to strengthen vaccination uptake and patient engagement.*

Introduction

Influenza, or "the flu," is a highly contagious acute viral respiratory infection caused mostly by influenza viruses A and B. Its major symptoms are rapid fever, sore throat, coughing, muscular pain, exhaustion, and, in some cases, a runny nose or nasal congestion. While most cases do not require treatment for recovery, influenza can cause serious symptoms and complications, such as pneumonia and sepsis, particularly in high-risk populations [1]. In developed countries, most influenza-related deaths occur among adults aged 65 and older [2]. This age group accounts for the largest share of hospitalizations and 62% of deaths. Workingage adults (18-64 years) also experienced significant mortality, with an estimated 7,800 deaths (36% of all influenza related deaths) [1]. Seasonal influenza spreads quickly in crowded and closed environments such as schools, nursing homes, and healthcare facilities. For more than 60 years, vaccination has been the most effective and safe strategy to prevent influenza. Individuals who are vaccinated protect themselves from severe morbidity and assist to minimize the spread of the virus, particularly in vulnerable groups such as the elderly and young children, reducing serious sickness [1, 3].
Annual vaccination is recommended since influenza viruses change every year, and the virus strains used for vaccine development are updated annually to protect against the most current threats [4].
The United States has a comprehensive national plan for influenza vaccination that aims to protect public health and minimize the impact of seasonal and pandemic influenza. The flu shot is recommended annually for almost every person who is 6 months of age and older [5]. Yet, coverage of the influenza vaccine remains suboptimal in the United States. During the 2023-24 flu season, influenza vaccination coverage among healthcare professionals was 75.4% [6] and similar proportions were found during the 2022-23 flu season (75.9%) [7]. These vaccination rates experienced a decline following the pandemic, as they previously stood at 80.6% [8, 9].
Influenza continues to pose a serious risk to public health, especially in healthcare settings where healthcare workers (HCWs) play an essential role in limiting and

preventing the virus's spread [1]. Yet, suboptimal uptake of influenza vaccines suggests the need for novel interventions, potentially engaging new messenger groups. Non-physician HCWs, represent a substantial portion of the workforce who serve as key influencers in vaccine acceptance and advocacy specifically among patients. However, the attitudes and behaviors toward influenza vaccination of this key population remain understudied [10]. Non-physician HCWs often have a positive view about vaccinations [11]. The tendency for vaccine uptake can often be motivated by a sense of duty and a wish to support public health efforts. These HCWs usually identify barriers to vaccination for their patients and the general public, rather than for themselves. Despite the positive attitude toward vaccinations that non-physician healthcare workers show, the vaccination rates against influenza in this population remain relatively low globally [12]. Several factors contribute to suboptimal influenza vaccination uptake among HCWs. Perceptual barriers such as low perceived risk of influenza, doubts about vaccine effectiveness, and concerns over side effects often reduce motivation. Behavioral and social influences, including lack of time and cultural attitudes, further limit coverage [1, 4]. Prior influenza vaccination has been linked to increased odds of recommending vaccination to others (OR=10.5; 95% CI=[5.38-20.3]; $p<0.001$) [13] suggesting that healthcare workers who get vaccinated themselves are more likely to advocate for vaccination.

The primary goal of the research study is to understand influenza vaccine advocacy attitudes and recommendation behaviors among non-physician healthcare workers. Specifically, the study aims to explore two key aspects: "Acceptance," focusing on how non-physician HCWs perceive and embrace influenza vaccination, and "Advocacy," examining their roles and actions in promoting influenza vaccination within their healthcare settings. Through this exploration, the study seeks to uncover insights that can describe non-physician HCWs behavior toward the influenza vaccine and assess potential factors that may influence influenza vaccine communication and/or uptake. The research findings may help to support the implementation of interventions aimed at supporting influenza vaccine uptake and fostering engagement in discussions with patients about vaccination by this vital group of healthcare professionals.

Methods

The study used a cross-sectional survey to explore influenza vaccination acceptance and advocacy behavior among non-physician HCWs.

This research did not receive grant funding agencies in the public, commercial, or not-for-profit sectors.

Population and sampling

The population of our study was non physician HCWs from a large Southern academic healthcare system. This included Medical/Nursing Assistants (MA/NA), Licensed Practical Nurses (LPN), Registered Nurses (RN), Pharmacists (PharmD) and Advanced Practice Providers (APP). APPs include Nurse Practitioners (NP), Physician Assistants (PA), Certified Registered Nurse Anesthetists (CRNA), and Certified Nurse Midwife (CNM). Other non-physician HCWs with patient contact roles were also included.

To be eligible to take the survey, individuals had to meet the following criteria:

Inclusion criteria:

- Be 18 years of age and above
- Fluent in English
- Non-physician HCW within large academic healthcare units
- Job role with direct patient contact.

Exclusion criteria:

- Physicians.

Participants were primarily selected through purposive sampling methods. The recruitment flyer was published weekly within a broadly distributed healthcare newsletter. The flyer outlined the study's objectives, procedures, and benefits including a QR code for easy access to the survey. Printed flyers were distributed within the healthcare facilities, and direct email invitations including detailed information about the study and a link to the survey were sent to non-physician HCWs for recruitment.

Study measures: MoVac-flu and MovAd-flu scales

The study utilized two previously established and validated scales:

- Motors of influenza vaccination acceptance (MoVac-flu): 9 items
- Motors of engagement with vaccination advocacy (MovAd-flu): 11 items.

The 'Motors of influenza vaccination acceptance' (MoVac-flu) and the 'Motors of engagement with vaccination advocacy' (MovAd-flu) scales were established and validated in prior studies by Vallée-Tourangeau et. al. We incorporated the most updated versions of both the MoVac-flu (9 items) and MovAd-flu (11 items) scales. Given that previous research has consistently demonstrated their accuracy and reliability [10, 14], we did not re-evaluate their internal consistency. Instead, our focus was on applying these validated scales to assess flu vaccination acceptance and advocacy behaviors. Numerous global studies have employed the MoVac and MovAd scales to evaluate vaccine acceptance and advocacy behaviors not only among healthcare workers but also across diverse key populations [14, 15]. Initially used with The National Health Service in the United Kingdom with direct patient contact, the study by Vallée-Tourangeau assessed the validity of the MoVac-Flu scale in predicting influenza vaccination status during the 2013-14 season. The analysis revealed that demographic factors alone did not significantly predict influenza vaccination behavior among healthcare workers. However, risk perception variables played a crucial role. This study confirmed that the MoVac-Flu and MovAd-

Flu scales were strong predictors of both vaccination uptake and advocacy behavior, even after accounting for demographic and risk perception variables. Because they produced more accurate results, the 9-item MoVac-flu scale and the 11-item MovAd-flu scale were adopted after it was shown that some items of the original 12-item scales were poor predictors [10, 14].The MoVac and MovAd scales are scored using a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree) and are meant to assess different empowerment feelings of healthcare workers:

- The value (How much the vaccine is important to protect the health worker's life and their patients)
- The impact (How much vaccination reduces the risk of catching the influenza virus)
- The knowledge (How much healthcare workers understand the benefit of influenza vaccination in protecting from the influenza virus)
- The autonomy (To which extent healthcare workers are free to choose to get vaccinated against influenza).

The MoVac and MovAd scales are grounded in Cognitive Model of Empowerment (CME). Unlike simple attitude or intention scales, they measure value, impact, knowledge, and autonomy, four empowerment domains that explain why individuals accept vaccination or advocate for it [10]. They go beyond correlating attitudes with uptake; they predict actual vaccination behavior and advocacy, making them useful for designing interventions [16].

Survey procedures

Our data collection instrument consisted of a one-time cross-sectional online survey conducted through Qualtrics XM™. Individuals who clicked on the survey link were presented with the consent form, the purpose of the study, and its voluntary nature. Individuals who clicked to continue were directed to the survey questionnaire. To guarantee that we are not collecting any identifiable data and ensuring participants can complete the survey without risking their anonymity, we used the specific tool on Qualtrics to "anonymize responses and disabled the collection of IP addresses before data collection. Consequently, identifying information was not retrievable for those responses.

Participation in the research study was completely voluntary, and no incentives were provided to individual participants.

The survey consisted of 5 sections:

- Screening questions
- Practices, attitudes, and comfort levels regarding influenza vaccination
- The MoVac-flu scale
- The MovAd-flu scale
- Demographic questions.

The survey was pre-tested and piloted with a group of 20 individuals including healthcare workers and others from the public health field whose demographic and professional features were comparable to those of the research population in order to guarantee clarity and ease of implementation. Multiple adjustments were carefully implemented in the survey, informed by valuable feedback received during the processes of survey testing and piloting.

Analysis plan

Participants responses were transferred to an Excel file, and data was cleaned and analyzed using R studio (version 2024.12.0, Build 467) descriptively, as well as using linear regression methods. Data were imported using the readxl package, cleaned and summarized using dplyr and tidyr, and analyzed using statistical procedures from the stats package. Kendall's Tau correlation and linear regression analyses were conducted using base R functions.

The demographic data, practices, attitudes, and comfort levels regarding influenza vaccination were summarized descriptively via frequencies (n, %). Kendall's Tau Correlation was employed to assess the strength and direction of the relationship between the participants' comfort level in discussing influenza vaccination with patients and their corresponding MoVac and MovAd scores. We used Kendall's Tau correlation instead of other statistical tests like Chi-square (χ^2) or Pearson correlation due to the nature of the variables as the comfort level in discussing vaccination is an ordinal variable and the MoVac and MovAd scores are continuous variables. Thus, since Kendall's Tau is used when at least one variable is ordinal, it is considered the most appropriate statistical test for our analysis. Additionally, Kendall's Tau is well-suited for small sample sizes and demonstrates robustness against outliers. Linear regression analysis was conducted to explore and quantify the meaningful association between the comfort levels and the two scores (MoVac and MovAd). This step aimed to further determine the extent to which the participants' comfort levels when engaging in vaccination discussions with patients could predict variations in MoVac and MovAd scores.

Linear regression was appropriate in this case because our outcome variables (MoVac and MovAd scores) were continuous and we used the numeric version of comfort level as the predictor to facilitate statistical analysis (1=Very uncomfortable, 2=Uncomfortable, 3=Neutral, 4=Comfortable and 5=Very comfortable).

Ethical considerations

This study adhered to strict ethical guidelines to ensure the protection and respect of all participants. Ethical approval was obtained from Emory institutional review board (IRB #: STUDY00008646), and the research was conducted in compliance with its standards. Additional Ethical and Religious Directives compliant review approval was obtained to be able to conduct research in certain hospitals within the academic healthcare system. Participation in the study was entirely voluntary, and consent was documented through clicking on the

"continue button" in the beginning of the survey.

To safeguard participants' privacy and confidentiality, all survey responses were anonymized, and no identifying information was recorded through the data collection instrument. Data was stored indefinitely within secure systems (OneDrive). During the study, only authorized study team members had access to the data. Data may be shared with other investigators or used for future analysis upon submission of a written request to the study team, which includes details of the use and protection of the data.

Furthermore, participants were provided with detailed information about the purpose of the study, their rights to withdraw at any time, and how the data would be used. Participants were encouraged to voice any concerns or ask questions at any point during the process, and measures were taken to reduce harm or discomfort while taking the survey. The study sought to guarantee honesty, transparency, and consideration for the rights and welfare of all participants.

Results

Of 156 survey responses collected between February 4th, 2025, and March 15th, 2025, 141 were considered complete and included in the analysis. Fifteen responses were deemed incomplete and excluded from the analysis to ensure the accuracy and integrity of the study's findings.

A. Demographics

1. Healthcare role

Figure 1 shows the summary of healthcare roles reported by the participants. Registered nurses represented the largest group, comprising 39 individuals (27.7% of the total participants). This was followed by medical and nursing assistants, who accounted for 34 individuals (24.1%). The "other" category encompassed various roles, including Pharmacists, Speech-Language Pathologists, Clinical Dietitians, Social Workers, Respiratory Therapists and Certified Ophthalmic Medical Technologists, among others.

2. Age distribution

Figure 2 shows the age distribution of participants. Most participants were between the age range of 25 to 34 years (n=42, 29.8%). This group was followed by those aged 45 to 54 years (n=32, 22.7%).

3. Gender

Figure 3 shows the gender distribution of the participants. Most participants identified as female (n=119, 84.4%) compared to other genders.

4. Vaccination status

Figure 4 shows the vaccination status of the participants. Most participants (n=136, 96.4%) reported receiving the influenza vaccine during the 2024-2025 respiratory virus season.

B. Behavioral analysis

1. Frequency of discussing Influenza vaccination with patients

Figure 5 shows the frequency of discussing influenza vaccination with patients. The majority of participants indicated that they either sometimes (n=37, 26.2%) or rarely (n=36, 25.5%) discuss influenza vaccination with their patients during routine clinical visits. A smaller group of healthcare workers (n=11, 7.8%) reported always addressing this topic with their patients.

2. Factors influencing decisions to recommend influenza vaccination to patients

Figure 6 summarizes the factors influencing decisions to recommend influenza vaccination to patients. According

Fig. 1. Healthcare roles of participants.

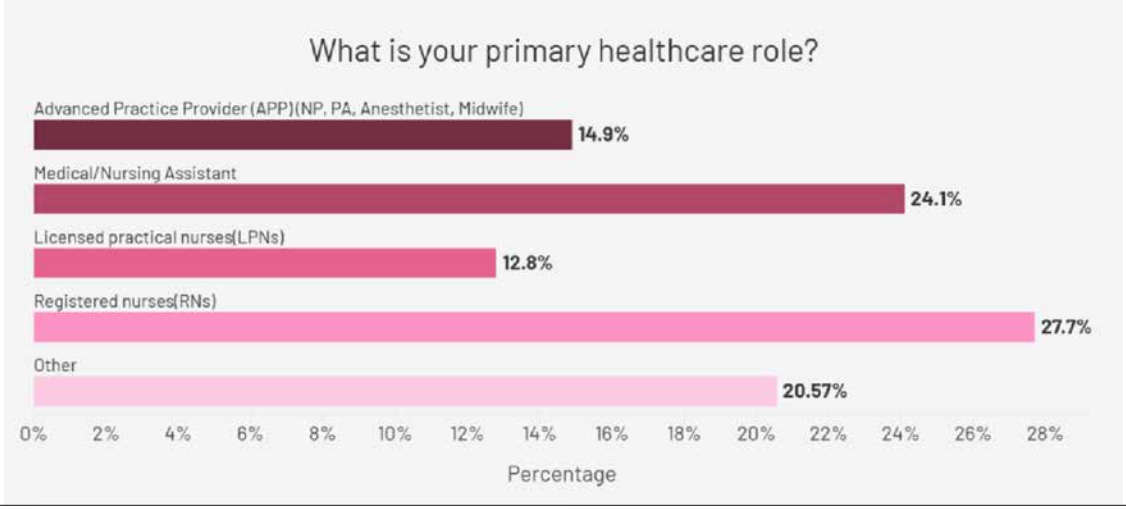


Fig. 2. Age distribution of participants.

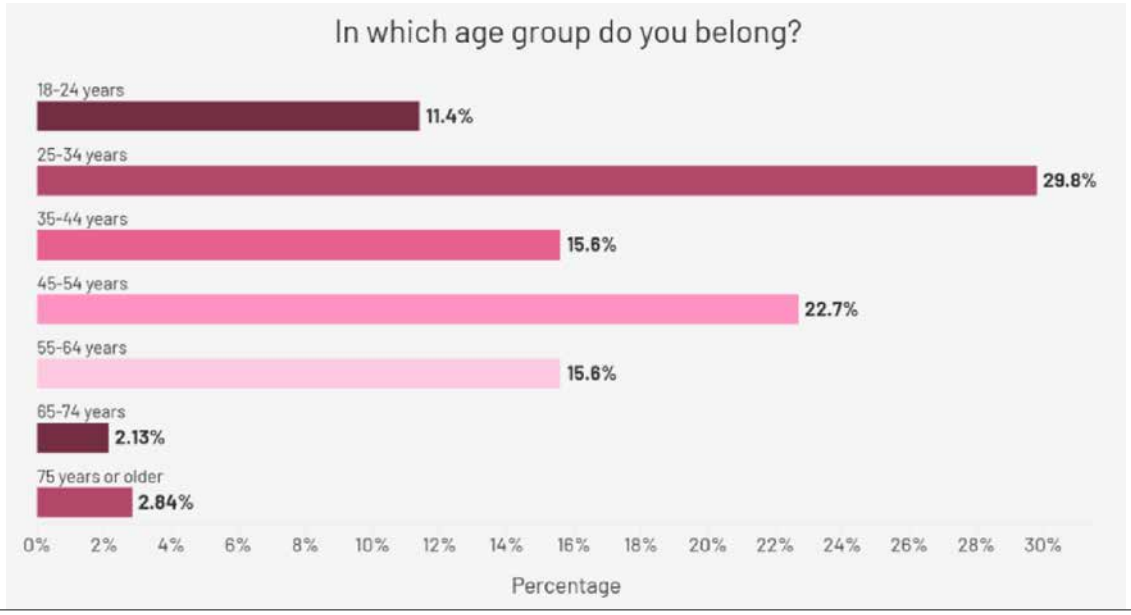


Fig. 3. Gender distribution of the participants.

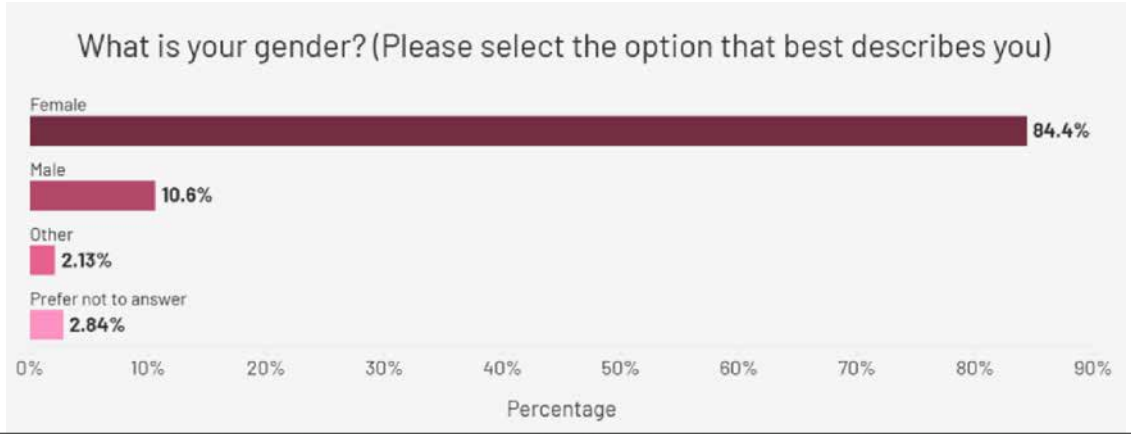
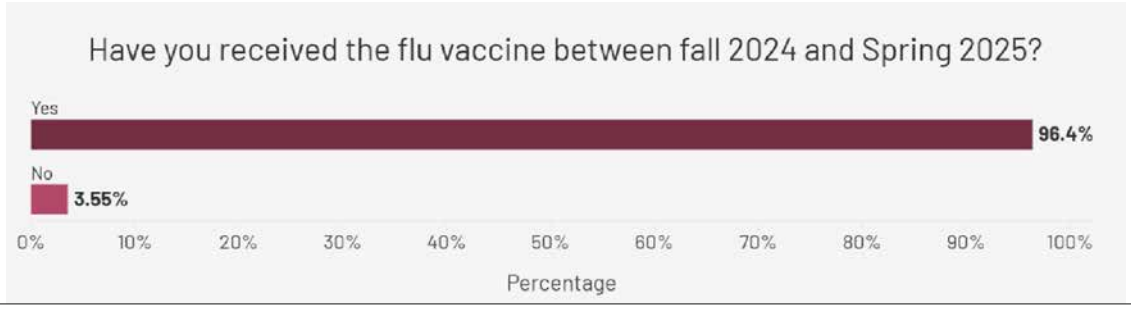


Fig. 4. Vaccination status of participants.



to participants, the most important factor influencing their recommendation of influenza vaccination to patients was clinical guidelines and recommendations (n = 89, 63.12%). This was followed by the patient's age and health status (n=80 participants, 56.7%). The least influential factor was the availability of vaccine stock in the clinic (n=49, 34.75%).

3. Level of comfort when discussing influenza vaccination with patients

Figure 7 shows the level of comfort reported by participants when discussing influenza vaccination with patients. Most participants reported feeling very comfortable discussing influenza vaccination with patients (n=56, 39.7%), followed by somewhat comfortable (n=35, 24.8%).

Fig. 5. Frequency of discussing influenza vaccination with patients.

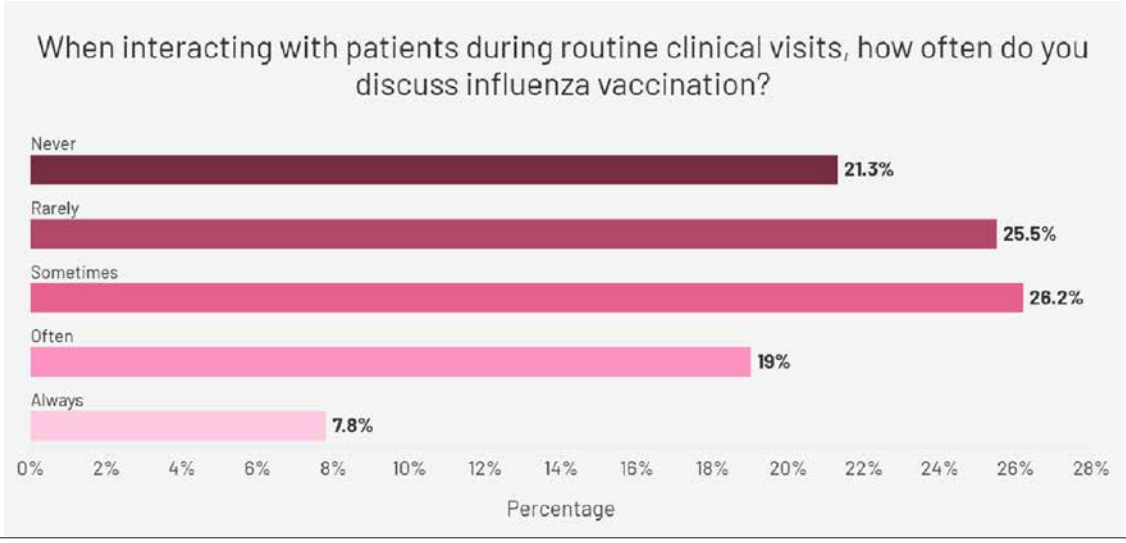


Fig. 6. Factors influencing decisions to recommend influenza vaccination to patients.

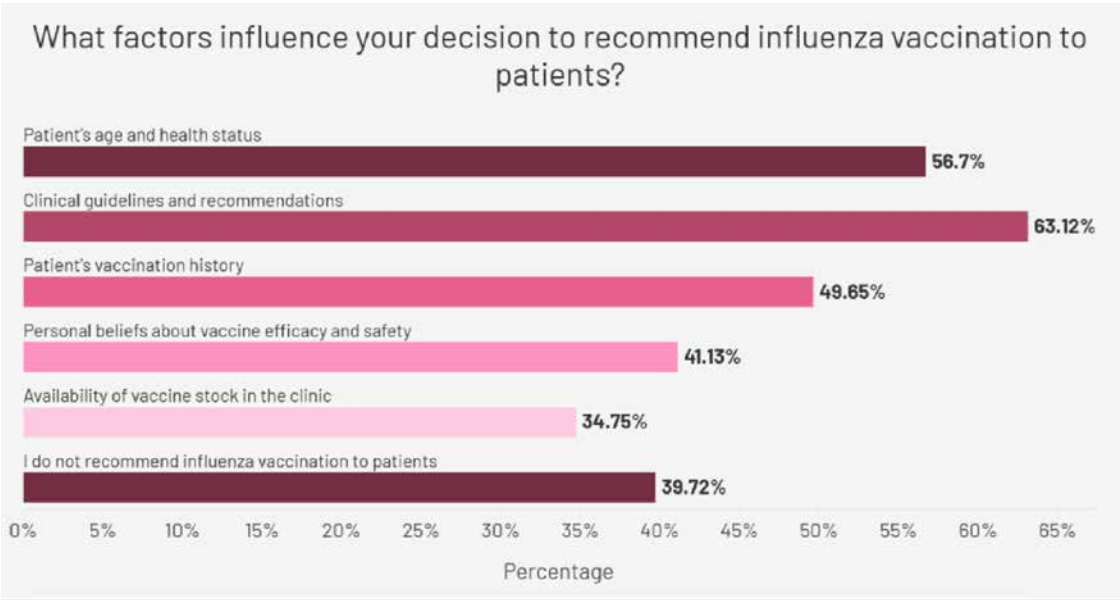
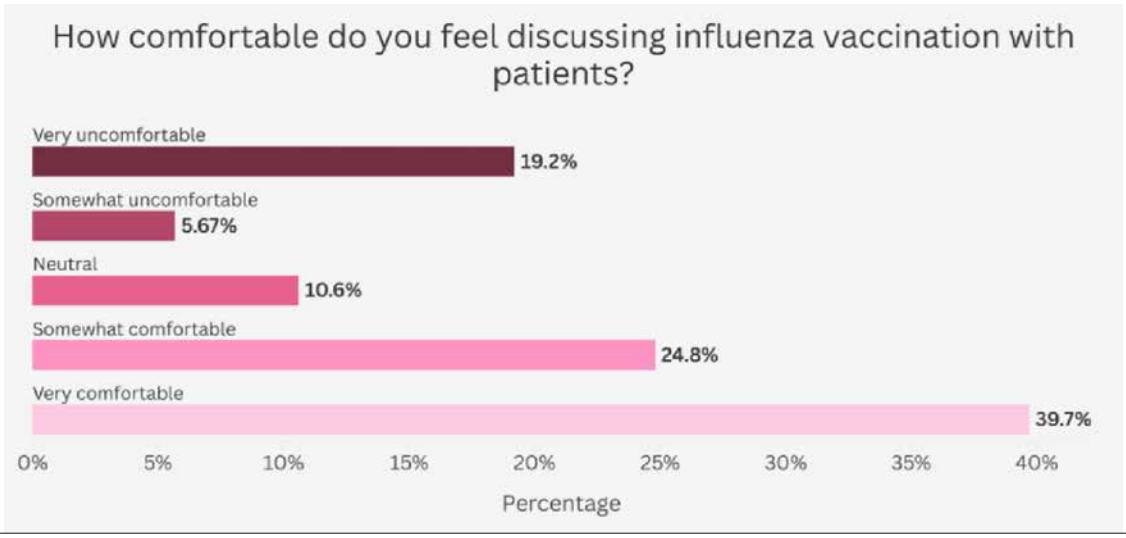


Fig. 7. Level of comfort when discussing influenza vaccination with patients.



Tab. I. Scores of the MoVac-flu scale and subscales.

	Mean	SD	Min	Max	Lower 95% CI	Upper 95% CI
MoVac score	5.31	1.43	1.00	7.00	5.07	5.55
MoVac Value score	5.43	1.61	1.00	7.00	5.16	5.70
MoVac Impact score	5.34	1.52	1.00	7.00	5.09	5.59
MoVac Knowledge score	5.74	1.43	1.00	7.00	5.50	5.97
MoVac Autonomy score	4.01	2.55	1.00	7.00	3.58	4.43

SD: Standard deviation, CI: Confidence Interval

Tab. II. Scores of the MovAd-flu scale and subscales.

	Mean	SD	Min	Max	Lower 95% CI	Upper 95% CI
MovAd score	4.77	1.27	1.00	7.00	4.56	4.98
MovAd Value score	4.68	1.71	1.00	7.00	4.40	4.97
MovAd Impact score	4.35	1.50	1.00	7.00	4.10	4.60
MovAd Knowledge score	5.19	1.28	1.00	7.00	4.98	5.40
MovAd Autonomy score	4.90	1.60	1.00	7.00	4.63	5.17

SD: Standard deviation, CI: Confidence Interval

Tab. III. Kendall's Tau and p-value.

Scale	Kendall's Tau	*p-value*
MoVac-flu	0.1632	0.01177*
MovAd-flu	0.3043	2.644e-06***

Signif. codes: 0'***' 0.001'**' 0.01'*' 0.05'.' 0.1'' 1

Tab. IV. Linear regression model results.

Scale	Kendall's Tau	*p-value*
MoVac-flu	0.1632	0.039*
MovAd-flu	0.26794	0.000108***

Signif. codes: 0'***' 0.001'**' 0.01'*' 0.05'.' 0.1'' 1

C. Calculation of MoVac and MoVad scores

Table I shows the MoVac-flu scale and subscale scores out of a maximum score of 7. The average MoVac score among participants was 5.31 (SD=1.43). Within subscales, the knowledge subscale had the highest score (mean=5.74, SD=1.43). In contrast, the autonomy subscale had the lowest score (mean=4.01, SD=2.55).
Table II shows the MoVac-flu scale and subscale scores out of a maximum score of 7. The average MovAd score calculated for the study population was 4.7 (SD=1.27). The knowledge subscale had the highest score (mean=5.19, SD=1.28). The impact subscale had the lowest score (mean=4.35, SD=1.5).

D. Kendall's Tau Correlation between the comfort level in discussing influenza vaccination and MoVac and MovAd scores

1. Correlation with MoVac score

Table III shows that Kendall's Tau was determined to be 0.1632, reflecting a weak positive correlation between the comfort level in discussing influenza vaccination and the MoVac score (p-value: 0.01177), indicating that this correlation is statistically significant at p<0.05.

2. Correlation with MovAd score

Table III shows that Tau was determined to be 0.3043, reflecting a moderate positive correlation between the comfort level in discussing influenza vaccination and the MovAd score (*p-value*=2.644e-06) indicating that this correlation is highly statistically significant at $p<0.05$.

E. Linear Regression between the comfort level in discussing influenza vaccination and MoVac and MovAd scores

1. MoVac score *vs*. the comfort level in discussing influenza vaccination

The linear regression model in Table IV reveals that the comfort level coefficient is 0.163, indicating that for each one-unit increase in the comfort level in discussing influenza vaccination, the MoVac score increases by 0.163 points (*p-value*=0.039), demonstrating statistical significance at $p<0.05$.
There is a weak positive but significant relationship between comfort in discussing vaccination and MoVac score. As comfort level increases, MoVac score tends to increase slightly.

2. MovAd score *vs*. the comfort level in discussing influenza vaccination

The linear regression model in Table IV reveals that the comfort level coefficient is 0.268, indicating that for each one-unit increase in the comfort level in discussing influenza vaccination, the MovAd score increases by 0.268 points (*p-value*=0.0001) demonstrating statistical significance at $p<0.05$.
There is a moderate positive and highly significant relationship between comfort in discussing vaccination and MovAd score. As the comfort level increases, MovAd score tends to increase more noticeably compared to MoVac score.

Discussion

Further studies conducted across a broader and more diverse population throughout Europe have reinforced the validity of the MoVac-flu and MovAd-flu scales [14-16]. These findings not only confirmed the robustness of the scale but also highlighted its strong predictive capacity for influenza vaccine uptake. This expanded research demonstrated that the scale remains reliable and effective when applied to a wider population.

Since their development, the two scales have been utilized across numerous regions globally, including Europe, Eurasia, North Africa, and the Middle East [17]. Their adaptability has been demonstrated through translations into multiple languages [18] enabling their application not only among HCWs but also other diverse demographic groups, such as elderly populations, and university students [15, 18]. This widespread usage underscores their versatility and reliability as tools for understanding vaccination behaviors. Furthermore, their integration into varied cultural and professional contexts highlights their effectiveness in exploring different behaviors regarding influenza vaccine acceptance and advocacy on an international scale.

Since the onset of the COVID-19 pandemic, a new scale known as the MoVac-COVID19S was established, specifically tailored to assess acceptance of Covid-19 vaccines. This scale has been widely adopted in various research projects with the shared goal of understanding vaccine acceptance dynamics [19]. The MoVac-COVID19S Scale was derived from the MoVac-flu scale, maintaining the original 9-item structure while shifting its focus to the Covid-19 vaccine. The scale was implemented with diverse populations, primarily in Asian countries such as China, Taiwan, Indonesia, and Malaysia [19, 20], then in New Zealand [21]. The MoVac-COVID19S scale has eventually been proven as a good predictor for vaccination engagement among the general population.

This large implementation of MoVac and MovAd scales around the world provided critical insights into the optimal use of these scales within our study. It helped us determine the most effective approach for assessing influenza vaccine acceptance and advocacy behaviors among our target population. Although previous studies' methods and protocols varied, they all came to similar conclusions. The MoVac-flu and MovAd-flu scales were considered to be in line with the Cognitive Model of Empowerment (CME) [10, 21], which takes into account autonomy, knowledge, influence, and value. The internal consistency of both scales was good [18]. These MoVac-flu and MovAd scales aligned with other validated measures, such as the Multidimensional Health Locus of Control, reinforcing the importance of HCWs' beliefs in vaccine utility and personal responsibility in improving immunization rates [22].

It is important to note that there is a gap in research in exploring non-physician HCW attitudes and advocacy toward influenza vaccine within the United States. By assessing both the acceptance and advocacy of influenza vaccination among non-physician HCWs, our study explored factors influencing vaccine-related decision-making within this population. The findings from this research study can potentially strengthen workplace vaccination policies, enhance healthcare workers' engagement in vaccine advocacy and recommendation, and ultimately improve patient health outcomes.

Most participants in our study were female, accounting for 84.4% of the sample. This demographic distribution is consistent with this healthcare system workforce, where 73% of its employees identify as female [23]. This healthcare system data also shows that the most common certification among employees is Certified Nurse Assistant (CNA) representing 18% of total employees [24]. This aligns with our findings, as the study population's composition showed that medical and nursing assistants accounted for 24.1% of all participants, following registered nurses, who comprised 27.7% of the total sample.

Our findings show that 96.4% of the total participants have received the influenza vaccine during the 2024-25 respiratory virus season. Influenza vaccination is mandatory for all health providers working at this healthcare system, unless they have medical contraindications or a religious exemption [25].

Our study found that discussions about influenza vaccination among HCW varied significantly. While 26.2% of participants reported occasionally addressing the topic with their patients, 25.5% admitted to discussing it rarely, and 21.3% stated that they never brought it up [26]. These findings suggest that even though HCWs might support recommending the vaccine, they do not necessarily engage in conversations about it with their patients. Additionally, this trend of not discussing the influenza vaccine often can be attributed to the diverse roles within our healthcare population. In certain specialized departments, discussing influenza vaccination may not be a routine part of patient interactions, which likely explains why most respondents either rarely or never engage in these conversations. This insight emphasizes the need to address communication gaps in vaccine advocacy efforts.

Moreover, our study revealed that multiple factors influenced recommendation behaviors toward influenza vaccination. 63.12% of participants mentioned clinical guidelines and recommendations as the major factor to influence their decision to recommend influenza vaccination to their patients. These findings align with previous research, which highlighted the influential role of supervisors and institutional leaders in promoting vaccination [27, 28]. Furthermore, studies showed that individuals who obtain vaccination information from official health sources are more likely to get vaccinated and consequently advocate for the vaccine [29]. Additionally, patients age and health status emerged as significant factors influencing HCWs' decisions to recommend the influenza vaccine. In our study, 56.7%

of participants identified this as a primary reason for their recommendations.

Regarding the level of comfort of discussing influenza vaccination with their patients, almost 40% (39.7%) of HCWs reported being very comfortable, while 24.8% stated being somewhat comfortable. Prior research has yielded different findings on this topic. While some HCWs felt comfortable discussing influenza vaccination, as they believed in its efficacy and positive impact on patient health, others experienced discomfort due to misconceptions about the vaccine's safety or effectiveness [30, 31]. The variation of the comfort levels of HCWs in discussing the influenza vaccine is attributed to risk perception [10] or discomfort due to skepticism or misinformation [15]. Thus, even though most of our population received the influenza vaccine, this does not necessarily reflect on their comfort level to advocate for it. Therefore, examining the correlation between the level of comfort of discussing the influenza vaccine and MoVac and MovAd scores provides stronger evidence for the connection between the comfort level and acceptance and advocacy behavior.

Our findings have shown that the average MoVac-flu score of non-physician HCWs was 5.31 (SD=1.43) which is above the mid-point of 4, suggesting a strong acceptance of the influenza vaccine. The knowledge subscale showed the highest score, averaging 5.74 (SD=1.43). This suggests that non-physician HCWs feel confident in their understanding of the influenza vaccine. Conversely, the autonomy subscale had the lowest score, recorded at 4.01, with considerable variation among participants (SD=2.55). This discrepancy can be attributed to the HCW influenza vaccine mandate [25, 32].

The average MovAd score for non-physician HCWs was 4.7 (SD=1.27), indicating a positive attitude toward advocating for the influenza vaccine. However, this score is lower than the MoVac score (MoVac=5.74). These findings support our earlier assertion that accepting the influenza vaccine does not necessarily equate to being motivated to advocate for it. Similarly, a Greek study reported comparable results, with a MovAd score of 4.7 (SD=1.2), further validating our interpretations [15]. Similar to the MoVac score, the knowledge subscale of the MovAd score had the highest score, calculated at 5.19 (SD=1.28). This confirms that non-physician HCWs feel confident in their ability to answer questions and offer advice about the influenza vaccine. On the other hand, the impact subscale of the score was the lowest among all assessed aspects, with a value of 4.35 (SD=1.5). This reflects that even though non physician HCWs believe in their ability to advocate for the influenza vaccine; they are less confident in the impact that vaccine advocacy can have on the general population. A previous study reported comparable results, with the impact score calculated at 4.5 (SD=1.3) [15]. On the other hand, another study conducted in multiples countries in Europe have found a better impact score (5.67, SD=1.2) suggesting that HCW believed that their advocacy for the influenza vaccine can have a great impact [14]. These discrepancies may be attributed to differences in the study populations. While the European study covered all healthcare professionals, including physicians, our research specifically examined non-physician HCWs. The inclusion of physicians in the population could suggest that they have greater confidence in the influence of their recommendations on patient decisions and consequently a greater impact score. In fact, the National Foundation for Infectious Diseases surveys indicate that 51% of patients who have received or plan to receive an influenza vaccine cite their doctor's recommendation as a key motivating factor [27].

Our findings demonstrated that there is a positive significant correlation between the comfort level in discussing influenza vaccination with patients and MoVac and MovAd scores. The linear regression model indicates that for each one-unit increase in the comfort level in discussing influenza vaccination, the MoVac score increases by 0.163 points (p=0.039) and the MovAd score increases by 0.268 points (p=0.0001). Thus, the comfort level in discussing influenza vaccination is considered a significant predictor for vaccination acceptance and advocacy. Previous research has identified various predictors of vaccination behavior. For example, demographic factors such as country of origin and age have been shown to be significant indicators [14]. Additionally, behavioral aspects like risk perception have proven to be strong predictors of vaccination behavior [10]. Analyzing the relationship between the comfort level in discussing the influenza vaccine and the MoVac and MovAd scores can illustrate the extent to which feeling confident and at ease with vaccination discussions predicts its acceptance among non-physician HCWs, as well as their willingness to advocate for it.

Strengths and limitations

Sample Size and Representativeness

Our study included 141 participants from various healthcare facilities. While this exceeds the threshold recommended by Green's rule for regression models (N≥104 + k, with k=1 predictor; minimum 105 participants) [33], challenges remain in determining representativeness. Available resources categorize nonphysician HCWs collectively as "staff members" without specifying the total number in direct patient contact or their distribution across hospitals, clinics, and other settings [23]. Nevertheless, the sample size is sufficient for meaningful statistical analyses and enhances the study's power to detect smaller effects.

Study Design and Sampling Methods

Participants were recruited through purposive sampling, which may not fully represent the broader healthcare workforce. Voluntary participation could have led to overrepresentation of HCWs supportive of vaccination, while those with negative views may have opted out.

Reliance on selfreported behaviors introduces potential recall and social desirability biases. Moreover, the crosssectional design captures data at a single point in time, limiting causal inference. Future longitudinal or experimental studies could provide deeper insights into vaccine advocacy and acceptance.

Variability and Novelty

Because influenza vaccination is mandated for all healthcare providers in our study setting, MoVacflu scores could not be used to predict uptake due to limited variability in vaccination behavior [16]. Similarly, restricted gender variability prevented assessment of gender as a predictor. This limitation redirected focus toward behavioral factors, such as comfort in discussing vaccination, which showed meaningful associations with MoVac and MoVad scores. A notable strength is that this study represents one of the first applications of these scales among nonphysician HCWs, contributing novel insights despite limited comparability with prior research.

Conclusion

By establishing a foundational exploration of advocacy attitudes and recommendation behaviors among non-physician HCWs our research serves as a valuable starting point for future studies to build upon.

Overall, both acceptance and advocacy levels were found to be good, reflecting positive attitudes toward vaccination and active engagement in promoting it. However, two specific dimensions showed only moderate outcomes. The autonomy subscale, which measures the extent to which HCWs feel free to choose vaccination, and the impact subscale, which reflects the perceived influence of their advocacy efforts. These areas represent important targets for intervention.

Evidence based strategies should therefore focus on strengthening HCWs' sense of autonomy and enhancing the perceived impact of their recommendations. Tailored workplace policies and institutional support have previously doubled vaccination rates among HCWs [34]. By reinforcing these aspects, interventions can improve both HCWs' confidence and their effectiveness in vaccine advocacy.

Finally, by situating nonphysician HCWs at the center of vaccine advocacy, the findings of our study could support broader public health initiatives aimed at reducing the burden of respiratory diseases on a global level, increasing seasonal influenza vaccination rates, and enhancing preparedness for future respiratory virus threats.

Acknowledgements

We would like to express our special thanks to the dedicated participants in this research, and everyone who played a role in the implementation of this research project and facilitated the data collection process.

Conflict of interest statement

There are no conflicts of interest of a financial, personal, or any other nature that could have influenced or biased the conduct of this study. This study did not receive any funding, and no external sources were involved in the study design, data acquisition, analysis, interpretation, or writing of the manuscript.

Author's contributions

OS: Led the preparation and submission of the IRB proposal, and coordinated revisions based on reviewer feedback. He developed the survey tool, facilitated discussions with co-authors regarding edits, and conducted pilot testing. He managed participant coordination and oversaw data collection, including cleaning and analysis. In addition, he drafted the manuscript. LV: Supervised the IRB submission process, contributed to testing and refining the survey tool, and guided the manuscript writing. She provided critical revisions throughout the drafting process. ZW: Oversaw the development of the IRB proposal, participated in testing and refining the survey tool, and supported data collection efforts in collaboration with partners and health facilities. She also contributed to manuscript review and provided substantive edits.

References

[1] World Health Organization. *Influenza (Seasonal).* Available at: https://www.who.int/news-room/fact-sheets/detail/influenza-(seasonal). Accessed on: 11/04/2025.

[2] Thompson WW, Weintraub E, Dhankhar P, Cheng PY, Brammer L, Meltzer MI, Bresee JS, Shay DK. Estimates of US influenza-associated deaths made using four different methods. Influenza Other Respir Viruses 2009;3:37-49. https://doi.org/10.1111/j.1750-2659.2009.00073.x.

[3] Healthy Children. *Which Flu Vaccine Should Children Get?* Available at: https://www.healthychildren.org/English/health-issues/conditions/flu/Pages/which-flu-vaccine-should-my-child-get-this-year.aspx. Accessed on: 11/04/2025.

[4] Centers for Disease Control and Prevention. *Who Should and Who Should NOT Get a Flu Vaccine.* Available at: https://www.cdc.gov/flu/prevent/whoshouldvax.htm. Accessed on: 11/04/2025.

[5] Centers for Medicare & Medicaid Services. *Flu Shot.* Available at: https://www.cms.gov/flu-provider. Accessed on: 11/04/2025.

[6] Centers for Disease Control and Prevention CDC. *Influenza and COVID-19 Vaccination Coverage Among Health Care Personnel – United States, 2023-24 Influenza Season.* Available at: https://www.cdc.gov/fluvaxview/coverage-by-season/health-care-personnel-coverage-2023-24.html#cdc_report_pub_study_section_6-authors. Accessed on: 11/04/2025.

[7] Centers for Disease Control and Prevention CDC. *Influenza Vaccination Coverage Among Health Care Personnel – United States, 2022–23 Influenza Season.* Available at: https://www.cdc.gov/fluvaxview/coverage-by-season/health-care-person-

nel-2022-2023.html#cdc_report_pub_study_section_6-authors. Accessed on: 11/04/2025.

[8] Centers for Disease Control and Prevention . *Influenza Vaccination Coverage Among Health Care Personnel – United States, 2019–2020 Influenza (Seasonal).* Available at: https://www.cdc.gov/fluvaxview/coverage-by-season/health-care-personnel-2019-2020.html#cdc_report_pub_study_section_6-authors. Accessed on: 11/04/2025.

[9] Bell J, Meng L, Barbre K, Haanschoten E, Reses HE, Soe M, Edwards J, Massey J, Tugu Yagama Reddy GR, Woods A, Stuckey MJ, Kuhar DT, Bolden K, Dubendris H, Wong E, Rowe T, Lindley MC, Kalayil EJ, Benin A. Influenza and Up-to-Date COVID-19 Vaccination Coverage Among Health Care Personnel - National Healthcare Safety Network, United States, 2022-23 Influenza Season. MMWR Morb Mortal Wkly Rep 2023;72:1237-43. https://doi.org/10.15585/mmwr.mm7245a5.

[10] Vallée-Tourangeau G, Promberger M, Moon K, Wheelock A, Sirota M, Norton C, Sevdalis N. Motors of influenza vaccination uptake and vaccination advocacy in healthcare workers: Development and validation of two short scales. Vaccine 2018;36:6540-5. https://doi.org/10.1016/j.vaccine.2017.08.025.

[11] Burrowes SAB, Casey SM, Dobbins S, Hall T, Ma M, Bano R, Drainoni ML, Schechter-Perkins EM, Garofalo C, Perkins RB, Pierre-Joseph N. Healthcare workers' perspectives on the COVID-19 vaccine and boosters for themselves, their patients, and their communities: a mixed methods study. Z Gesundh Wiss 2022 Dec 25:1-14. https://doi.org/10.1007/s10389-022-01793-1.

[12] Fan J, Xu S, Liu Y, Ma X, Cao J, Fan C, Bao S. Influenza vaccination rates among healthcare workers: a systematic review and meta-analysis investigating influencing factors. Front Public Health 2023;11:1295464. https://doi.org/10.3389/fpubh.2023.1295464.

[13] Hamdan O, Amarin JZ, Potter M, Haddadin Z, Yanis A, Shawareb Y, Khuri-Bulos N, Haddadin R, Halasa NB, Spieker AJ. Seasonal influenza vaccination: Attitudes and practices of healthcare providers in Jordan. PLOS ONE 2024;19:e0314224. https://doi.org/10.1371/journal.pone.0314224.

[14] Kassianos G, Kuchar E, Nitsch-Osuch A, Kyncl J, Galev A, Humolli I, Falup-Pecurariu O, Thomson A, Klein C, Vallée-Tourangeau G. Motors of influenza vaccination uptake and vaccination advocacy in healthcare workers: A comparative study in six European countries. Vaccine 2018;36:6546-52. https://doi.org/10.1016/j.vaccine.2018.02.031. Epub 2018 Mar 28.

[15] Dardalas I, Pourzitaki C, Manomenidis G, Malliou F, Galanis P, Papazisis G, Kouvelas D, Bellali T. Predictors of influenza vaccination among elderly: a cross-sectional survey in Greece. Aging Clin Exp Res 2020;32:1821-8. https://doi.org/10.1007/s40520-019-01367-4.

[16] Bellali T, Liamopoulou P, Karavasileiadou S, Almadani N, Galanis P, Kritsotakis G, Manomenidis G. Intention, Motivation, and Empowerment: Factors Associated with Seasonal Influenza Vaccination among Healthcare Workers (HCWs). Vaccines 2023;11:1508. https://doi.org/10.3390/vaccines11091508.

[17] Tanriover MD, Vallee-Tourangeau G, Kokorin VA, Larina VN, Maamar M, Harmouche H, Uyaroğlu OA, Kutlay DY, Ben Khelil J, Anjorin AA, Rana MS, Jabrayilov J, Al Slail F, Al Kathiry D, Al Harthi H, Ghazy RM, Gahwagi M, Mafi A, Koul P, Al Awaidy S. The vaccination acceptance, confidence, and conviction on influenza in the Middle East, Eurasia, and Africa among healthcare providers (VACCIMENA-HCP) project 2023: Determinants of vaccination behavior. IJID reg 2025;14:100572. https://doi.org/10.1016/j.ijregi.2025.100572.

[18] Cortes García-Rodríguez L, Luengo-González R, Nieves Moro-Tejedor M, Asenjo-Esteve A, Montserrat García-Sastre M, Cuesta-Lozano D. Adaptación y validación de la escala MoVac-flu sobre motivación hacia la vacuna de la gripe. Gaceta Sanitaria 2023;37:102345. https://doi.org/10.1016/j.gaceta.2023.102345.

[19] Chen IH, Ahorsu DK, Ko NY, Yen CF, Lin CY, Griffiths MD, Pakpour AH. Adapting the Motors of Influenza Vaccination Acceptance Scale into the Motors of COVID-19 Vaccination Acceptance Scale: Psychometric evaluation among mainland Chinese university students. Vaccine 2021;39:4510-5. https://doi.org/10.1016/j.vaccine.2021.06.044.

[20] Pramukti I, Strong C, Chen IH, Yen CF, Rifai A, Ibrahim K, Pandin MGR, Subramaniam H, Griffiths MD, Lin CY, Ko NY. The Motors of COVID-19 Vaccination Acceptance Scale (MoVac-COVID19S): Measurement Invariant Evidence for Its Nine-Item Version in Taiwan, Indonesia, and Malaysia. Psychol Res Behav Manag 2022;15:1617-25. https://doi.org/10.2147/PRBM.S363757. Erratum in: Psychol Res Behav Manag 2022;15:1915-6. https://doi.org/10.2147/PRBM.S383784.

[21] Adu P, Popoola T, Collings S, Aspin S, Medvedev O, Simpson C. Psychometric properties of the motors of COVID-19 vaccination acceptance scale in New Zealand: Insights from confirmatory factor analysis. Current Psychology 2024;26628-38. https://doi.org/10.1007/s12144-024-05877-x.

[22] Lin C, Mullen J, Smith D, Kotarba M, Kaplan SJ, Tu P. Healthcare Providers' Vaccine Perceptions, Hesitancy, and Recommendation to Patients: A Systematic Review. Vaccines (Basel) 2021;9:713. https://doi.org/10.3390/vaccines9070713.

[23] Emory University. *Comprehensive Figures.* Available at: https://whsc.emory.edu/about/facts-figures/figures.html. Accessed on: 17/04/2025.

[24] Zippia. *Emory Healthcare demographics and statistics.* Available at: https://www.zippia.com/emory-healthcare-careers-22447/demographics/. Accessed on: 18/04/2025.

[25] Emory Healthcare. *For Medical Professionals.* Available at: https://www.emoryhealthcare.org/medical-professionals/credentialing/prevent-the-spread#:~:text=to%20influenza%20vaccination.-,The%20vaccine%20is%20mandatory%20for%20all%20providers%2C%20except%20those%20with,for%20an%20exemption%20each%20year. Accessed on: 18/04/2025.

[26] Haridi HK, Salman KA, Basaif EA, Al-Skaibi DK. Influenza vaccine uptake, determinants, motivators, and barriers of the vaccine receipt among healthcare workers in a tertiary care hospital in Saudi Arabia. J Hosp Infect 2017;96:268-75. https://doi.org/10.1016/j.jhin.2017.02.005. Epub 2017 Feb 9.

[27] National Foundation for Infectious Diseases NFID. NFID Surveys Find Gaps in Communication about Flu Between Healthcare Professionals and Patients with Chronic Health Conditions. Available at: https://www.nfid.org/nfid-surveys-find-gaps-in-communication-about-flu-between-healthcare-professionals-and-patients-with-chronic-health-conditions/. Accessed on: 18/04/2025.

[28] Association of Professionals in Infection Control and Epidemiology. APIC Position Paper: Influenza Vaccination Should Be a Condition of Employment for Healthcare Personnel, Unless Medically Contraindicated. Available at: https://www.apic.org/Resource_/TinyMceFileManager/Advocacy-PDFs/APIC_Influenza_Immunization_of_HCP_12711.pdf. Accessed on: 18/04/2025.

[29] Bish A, Yardley L, Nicoll A, Michie S. Factors associated with uptake of vaccination against pandemic influenza: a systematic review. Vaccine 2011;29:6472-84. https://doi.org/10.1016/j.vaccine.2011.06.107.

[30] Kaddour O, Ben Mabrouk A, Arfa S, Lassoued N, Berriche O, Chelli J. Knowledge and attitudes of healthcare workers about influenza vaccination. Infect Dis Health 2024;29:203-211. https://doi.org/10.1016/j.idh.2024.04.005.

[31] Guillari A, Polito F, Pucciarelli G, Serra N, Gargiulo G, Esposito MR, Botti S, Rea T, Simeone S. Influenza vaccination and healthcare workers: barriers and predisposing factors. Acta

Biomed 2021;92:e2021004. https://doi.org/10.23750/abm.v92iS2.11106.

[32] Goje O, Kapoor A. Meeting the challenge of vaccine hesitancy. Cleve Clin J Med 2024;91:S50-6. https://doi.org/10.3949/ccjm.91.s1.08.

[33] Green SB. How Many Subjects Does It Take To Do A Regression Analysis. Multivariate Behav Res 1991;26:499-510. https://doi.org/10.1207/s15327906mbr2603_7.

[34] Zaraketa H, Abubakar A. Harnessing the power of advocacy to improve seasonal influenza vaccination coverage in the Eastern Mediterranean Region. East Mediterr Health J 2020;26:138-40. https://doi.org/10.26719/2020.26.2.138.

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Infectious diseases

Twenty years after the implementation of HBV vaccination: Epidemiology and risk factors for hepatitis B infection in the south of Bosnia and Herzegovina

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Keywords

Epidemiology • Hepatitis B • Vaccination • Risk factors • Bosnia and Herzegovina

Summary

Introduction. *According to the World Health Organization, Global hepatitis report 2024, there were 254 million people living with HBV. Vaccination, testing and antiviral treatment are currently available tools to prevent transmission of HBV infection, but also to prevent the progression of infection. The aim of this research was to identify epidemiological data and risky behaviors for infection twenty years after the implementation of vaccination.*
Methodology. *We performed a case-control study including 63 respondents that were in contact with HBV (HBsAg positive or anti-HBs and anti-HBc IgG positive) and 62 control respondents matched by gender and age. All of them completed a questionnaire focusing on sociodemographic characteristics and potential risk factors for HBV-infection.*
Results. *Out of a total of 63 respondents in the study group, 39 (61.9%) were male and 24 (38.1%) were female. The mean age was 56.90±15.576 years. There were no statistically significant differences between HBV cases and control participants with respect to employment status, educational level, or marital/intimate status.*
Contact with other people's blood was identified as a key risk factor for HBV infection, with blood transfusion being the most commonly reported route of exposure in this study.
Conclusion. *Twenty years after the introduction of mandatory vaccination against hepatitis B in Bosnia and Herzegovina, the dominant risk factor for the hepatitis B is contact with other people's blood, and the most common way of coming into contact with other people's blood is transfusion. On the other hand, the data obtained, that 20 years after the introduction of the hepatitis B vaccine, we see hepatitis B most often in older people speaks in favor of the favorable impact of vaccination on the movement of HBV.*

Introduction

HBV (hepatitis B virus) is a hepatotropic DNA (deoxyribonucleic acid) virus belonging to the *Hepadnaviridae* family. The virus has a lipid envelope with the viral surface antigen (Hepatitis B surface antigen, HBsAg) that surrounds the nucleocapsid, which contains the core protein (Hepatitis B core antigen, HBcAg), polymerase and the viral DNA [1]. According to the World Health Organization (WHO), Global hepatitis report 2024 there were 254 million people living with HBV [2]. The prevalence of HBV varies worldwide. There are high, medium and low endemicity areas according to HBsAg prevalence. Southeast Asia, sub-Saharan Africa, China, Indonesia and Nigeria are considered highly endemic areas with more than 8% of the population living with chronic hepatitis B. South America and countries of Central America, Southeast Europe and Southwest Asia belong to countries of medium endemicity with a prevalence of 2 to 7%, while countries of Western Europe and North America are areas of low endemicity [3]. The route of transmission varies according to the prevalence. In high-prevalence countries, the dominant route of transmission is vertical, from mother to child, while in low-prevalence countries, the dominant route of transmission is contact with the blood of intravenous drug users and the sexual route [4]. The latest data on the prevalence of HBsAg in Bosnia and Herzegovina are presented in 2022, showing a strong effect of the introduction of mandatory vaccination on HBsAg seroprevalence and a statistically significant decrease from 0.345% in 1998 to 0.028% in 2019 among voluntary blood donors [5]. The dominant route of transmission in high-prevalence countries is vertical from mother to child or horizontal through close family contact. In low-prevalence countries, HBV is transmitted mainly through intravenous drug usage, sexual contact and "piercing". HBV is still a risk in transfusion therapy. However, with the introduction and improvement of blood testing, today, the final risk of HBV transmission through transfusion in European countries ranges from 1 to 10 per million transfusions. Although transmission of HBV is also possible through a stabbing incident among health care workers, studies from Denmark, Germany, Turkey, and Albania have shown the same prevalence among health care workers as in the general population [6]. Vaccination, testing and antiviral treatment are currently available tools to

prevent the transmission of HBV infection, but also to prevent the progression of HBV infection [7]. Since 1980, HBV infection can be prevented with an effective vaccine [4]. According to WHO data, the percentage of chronically infected children under the age of five fell to 1% in 2019 compared to 5% before the introduction of vaccination [8]. Vaccination against HBV in Bosnia and Herzegovina was introduced in 1999 for first-graders, and in 2004, vaccination of newborns after birth was introduced according to the scheme 0, 1, 6 months.
This research aimed to identify risky behaviors and risk groups for HBV infection with the goal of directing prevention measures, more mass vaccination and testing, and possibly treatment in Bosnia and Herzegovina.

Methods

We performed the case control study on 63 subjects, which were serologically diagnosed with HBV infection in the period 2017-2021 (HBsAg positive or anti-HBs and anti-HBc IgG positive). The study included subjects who were diagnosed with current or past HBV infection during the specified period through serological testing for HBV markers, and who agreed to participate in the surveillance. Each subject from the examined group was assigned a control subject matched by gender and age. The research plan, purpose, and possible risks were explained in detail to all research participants from the experimental and control groups. The participants signed a consent form to participate in the research. After informed consent was obtained for every HBV-positive and control case, respondents filled out self-administered questionnaire. The questionnaire focused on sociodemographic status (gender, age, educational level and marital status) and potential risk factors for HBV infection (tattoo, piercing, transfusion, contact with blood, receiving clotting factors, transplantation, drug users, intimate relationship with HBV or HCV positive partner, sexual transmissive diseases, more than 2 sexual partners in last 12 months, sexual intercourse with a person of the same sex, a family member with viral hepatitis).
For all HBsAg-positive respondents, HBV-quantitative molecular testing was performed.
Serological testing (HBsAg, HBeAg, anti-HBs, anti-HBc IgG, anti-HBc IgM, anti-HBe) was performed using the Architect system (Abbott) and LIAISON® XL (DiaSorin), based on chemiluminescent immunoassay technology. HBV DNA testing was performed using the Abbott RealTime HBV assay which is an in vitro reverse transcription polymerase chain reaction (RT-PCR) quantitative assay. Molecular assay was used following the manufacturer's instructions using the Abbott m24 sample preparation and Abbott m 2000 rt modules.
Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp). The Chi-square test (χ^2) and Fisher's exact test for categorical variables were used to establish the difference between HBV-positive and control groups according to various respondent categories. The odds ratio (OR) and 95% confidence interval (CI) for the risk factors were calculated. A P value of 0.05 was considered to be statistically significant. A binary logistic regression calculation was used to assess the dominant risk factor.
Study was approved by the Ethics Committee No. 1898/16 and No. 01-1-234/16.

Results

Sociodemographic characteristics of HBV-positive individuals

The study included 63 respondents who were serologically diagnosed with HBV infection, and 62 control respondents. Out of a total of 63 respondents in the research group, 39 (61.9%) were men, and 24 (38.1%) were women. The average age was 56.90±15.576 years, with the youngest respondent being 19 and the oldest 91. The average age of men was 56.33± 4.592 years, with the youngest being 19 and the oldest 91. The average age of women was 57.83±17.342 years, with the youngest woman being 26 and the oldest 86.
There was no statistically significant difference between HBV and control respondents regarding employment status *(p*=0.071), educational level *(p*=0.336) and marital or intimate status *(p*=0.573) (Tab. I).

Risk factors for HBV infection

Risk factors for HBV infection were calculated by comparing the group of subjects who were in contact with HBV with the control group using the χ^2 test, the Odds Ratio (OR) and the 95% confidence interval (Tab. II). *p-value* 0.05 was considered to be statistically significant.
Of all the risk factors we observed, contact with other people's blood showed a statistically significant difference compared to the control group.
Answering the question of how they came into contact with other people's blood, the majority of respondents, eight of them (42.10%), indicated transfusion, seven (36.84%) providing help for various injuries, in the war and traffic accidents. Two healthcare professionals and one police officer reported contact with other people's blood at the workplace (15.79%).
Binary logistic regression of risk factors for HBV infection also singled out contact with other people's blood as a risk factor for HBV infection (Tab. III). In the binary logistic regression, only the variables where there was an incidence in both groups were included. Variables that were more frequent in the control group and variables with zero in one of the groups were not included in the model due to the impossibility of estimating the odds ratio (problem of complete separation).

Discussion

An analysis of the socio-demographic characteristics of the respondents who were in contact with HBV revealed that out of a total of 63 HBV subjects, 39 (61.9%) were

Tab. I. Socio-demographic characteristics of HBV infected respondents.

Socio-demographic characteristics		HBV group N=63	Control group N=62	*p*
		N (%)	N (%)	
Gender	Male	39 (61.9)	38 (61.3)	1.000*
	Female	24 (38.1)	24 (38.7)	
Age	0–40	7 (11.1)	7 (11.3)	0.991
	41–65	36 (57.2)	36 (58.1)	
	>65	20 (31.7)	19 (30.6)	
Employment	Employed	21 (33.3)	34 (54.8)	0.071
	Unemployed	13 (20.6)	6 (9.7)	
	Retired	29 (46.1)	22 (25.5)	
Educational level	Uncompleted elementary school	6 (9.5)	2 (3.2)	0.336
	Elementary school	8 (12.7)	7 (11.3)	
	Secondary school	42 (66.6)	41 (66.1)	
	High school/academy	7 (11.1)	12 (19.4)	
Marital/intimate status	Married	46 (73.0)	41 (66.1)	0.573
	Single	5 (7.9)	10 (16.1)	
	Widow	10 (15.9)	9 (14.5)	
	Divorced	2 (3.2)	2 (3.3)	

Tab. II. Risk factors for HBV infection.

Risk factors	HBV group N (%)	Control group N (%)	OR	95 % CI	*p*
	N=63	N=62			
Tattoo	9 (14.3)	11 (17.7)	0.773	0.296-2.019	0.863*
"Piercing"	5 (7.9)	0	_	_	0.058*
Transfusion	15 (24.2)	8 (12.9)	2.154	0.839-5.531	0.165
Contact with other people's blood	19 (30.2)	7 (11.3)	3.393	1.308-8.799	**0.014***
Receiving clotting factors	0	0	_	_	1.000
Transplantation	0	0	_	_	1.000
Drug usage	3 (4.8)	1 (1.6)	3.050	0.309-30.150	0.619
Intimate relationship with HBV or HCV positive partner	3 (4.8)	0	_	_	0.244
Sexual transmissive diseases	0	0	_	_	1.000
More than 2 sexual partners in the last 12 months	1 (1.6)	2 (3.2)	0.484	0.423-5.477	0.619*

*Fisher exact test

Tab. III. Binary logistic regression analysis of risk factors for HBV infection.

Variable	Adjusted OR	95% CI	*p-value*
Contact with other people's blood	2.92	1.03-8.27	0.044
Blood transfusion	1.46	0.51-4.19	0.478
Drug use	4.12	0.41-41.14	0.228

men and 24 (38.1%) were women, with the average age of the subjects 56.90±15.576 years.

Contact with other people's blood showed a statistically significant difference compared to the control group (p=0.014; OR=3.393). Binary logistic regression analysis also singled out contact with others people blood as risk factor for acquiring hepatitis B virus infection.

By comparing with the control group, no statistically significant difference was obtained according to gender and age, because the control group was chosen to be comparable in terms of gender and age to the research group. A higher frequency of HBV chronic carriage in men is already known in the literature, as well as a faster progression of liver damage. This data is linked to greater exposure to HBV in men, but also to a better immune response in eliminating the virus in women [9]. The average age of the subjects which were in contact with HBV of 56.90±15.576 years in Bosnia and Herzegovina, could be explained with the implementation of HBV vaccination. Namely, vaccination against HBV in Bosnia and Herzegovina was introduced in 1999 for first-graders, and in 2004, vaccination of newborns after birth was introduced according to the scheme 0, 1, 6 months. The effect of HBV vaccination on HBsAg seroprevalence was presented in a paper from 2022,

which showed a statistically significant decline in HBsAg seroprevalence from 0.345% in 1998 to 0.028% in 2019 among voluntary blood donors in Herzegovina. In the same paper, an increase in the average age of HBsAg-positive donors was also determined through three periods, namely 30.52±10.26; 37.56±10.13 and 47.28±12.14 during the periods from 1998 to 2002, from 2004 to 2008 and from 2015 to 2019 [5].

By analyzing potential risk factors for hepatitis B virus infection, comparing HBV group with the control group, only contact with other people's blood was singled out as statistically significantly more frequent among persons who were in contact with HBV.

The most common way in which the respondents came into contact with other people's blood was transfusion, however 15 (24.2%) of the respondents received blood. Other reported ways of coming into contact with other people's blood were providing help for injuries, in war and traffic accidents in seven (36.84%) respondents and contact with other people's blood at the workplace in two healthcare professionals and one police officer (15.79%). It is known that the risk of HBV transmission through transfusion is very low, but it is still higher compared to other potential causes of blood-borne diseases for which mandatory testing is prescribed [10]. This could be explained by the variability of the clinical presentation of hepatitis B virus infection and the immune response of the host, but also by the replication of the virus and the dynamics of serological markers of HBV infection, all of which complicates donor selection and screening [11].

"Piercing" is highlighted in the available literature as a risk factor for hepatitis B virus infection. Thus, a systematic review of 14 studies confirmed a statistically significant association between "body piercing" and hepatitis B virus infection. Although the same study showed a stronger risk effect of "piercing" for acquiring HCV compared to HBV, this data can be explained by the influence of vaccination [12]. Piercing was statistically more frequent among the anti-HCV-positive respondents compared to the control group in the study from 2024, but in the same study, binary logistic regression singled out drug usage as a dominant risk factor for acquiring HCV infection in Bosnia and Herzegovina [13].

Here, it is certainly important to mention the problem that population migration could bring with it. With the migration increase, there is also an increase in HBV prevalence in countries that were among low-prevalence countries. This is confirmed by the fact that the dominant risk factor for HBV infection in North America and Europe (including the UK) is actually the place of birth; an endemic area for HBV, intravenous drug use and male-to-male sex [14].

Contact with other people's blood and transfusion, as the most frequently mentioned way of coming into contact with other people's blood, still remains a threat in the transmission of HBV. Despite the introduction of molecular testing for viral DNA in transfusion activities, the residual risk still exists even in the most developed countries. The residual risk for HBV infection in transfusion practice is not limited to preseroconversion window period but it extends to donors with occult HBV infection (OBI) characterized by the presence of HBV DNA in liver and the absence of HBsAg [15]. However, among the potential recipients of blood products there are certainly people who have not passed the mandatory HBV vaccination program.

The average age of persons who were in contact with HBV speaks in favor of the positive impact of the introduction of vaccination against HBV, meaning that persons who were in contact with HBV were not included in the program of compulsory vaccination against HBV.

In this research we were unable to assess the risk of vertical transmission of HBV from mother to child due to the lack of information regarding the respondent's mothers HBV status at the delivery time. This survey also did not include testing of household members. The above mentioned and the number of participants included in the research represents the limitations of the research itself. Also, case–control design does not allow estimation of population-level prevalence of HBV infection. Future studies using population-based cross-sectional designs, potentially with nested case–control analyses, may provide more comprehensive insights into both prevalence and risk factors. Nevertheless, the present design is appropriate for identifying associations and generating hypotheses regarding HBV risk factors.

Conclusion

Twenty years after the implementation of mandatory HBV vaccination, people who have been in contact with HBV are more likely to be male and older, with no specific sociodemographic characteristics (employment status, educational level and marital or intimate status). Factor recognized as risk factor for acquiring HBV infection is contact with others people blood. The most common way of coming into the contact with other people's blood in this research was transfusion.

Although the higher average age of people who have been in contact with HBV confirms the positive impact of the introduction of vaccination, we should certainly be aware of the risk that comes with the migration of the unvaccinated population.

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Conflict of interest statement

None.

Authors' contributions

ITD: Conceptualization, data curation, formal analysis,

investigation, methodology, project administration, supervision, validation, visualization, writing - original draft and writing - review & editing.
BŠ: Conceptualization, data curation, formal analysis, investigation, methodology, validation, writing - original draft and Writing - review & editing.
JA: Conceptualization, methodology, project administration, supervision, validation, writing - original draft and writing - review & editing.

References

[1] Jiang B, Hildt E. Intracellular Trafficking of HBV Particles. Cells 2020;9:2023. https://doi.org/10.3390/cells9092023.

[2] World Health Organization (2024). Global hepatitis report 2024. World Health Organization, Geneva. Available at:https://www.who.int/publications/i/item/9789240091672. Accessed on: 29/05/2026.

[3] Villar LM, Cruz HM, Barbosa JR, Bezerra CS, Portilho MM, Scalioni L de P. Update on hepatitis B and C virus diagnosis. World J Virol 2015;4:323-42. https://doi.org/10.5501/wjv.v4.i4.323.

[4] Odenwald MA, Paul S. Viral hepatitis: Past, present, and future. World J Gastroenterol 2022;28:1405-29. https://doi.org/10.3748/wjg.v28.i14.1405.

[5] Drlje IT, Arapović J. Prevalence of hepatitis B surface antigen (HBsAg) in blood donor population in Bosnia and Herzegovina: Impact of the pre-donation questionnaire implementation and mandatory hepatitis B virus (HBV) vaccination schedule - 20 years' experience of the University Clinical Hospital Mostar. Transfus Clin Biol J Soc Francaise Transfus Sang 2022;29:231-5. https://doi.org/10.1016/j.tracli.2022.03.008.

[6] Rantala M, van de Laar MJW. Surveillance and epidemiology of hepatitis B and C in Europe - a review. Euro Surveill Bull Eur Sur Mal Transm Eur Commun Dis Bull 2008;13:18880. https://doi.org/10.2807/ese.13.21.18880-en.

[7] GBD 2019 Hepatitis B Collaborators. Global, regional, and national burden of hepatitis B, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet Gastroenterol Hepatol 2022;7:796-829. https://doi.org/10.1016/S2468-1253(22)00124-8.

[8] Veronese P, Dodi I, Esposito S, Indolfi G. Prevention of vertical transmission of hepatitis B virus infection. World J Gastroenterol 2021;27:4182-93. https://doi.org/10.3748/wjg.v27.i26.4182.

[9] Stroffolini T, Esvan R, Biliotti E, Sagnelli E, Gaeta GB, Almasio PL. Gender differences in chronic HBsAg carriers in Italy: Evidence for the independent role of male sex in severity of liver disease. J Med Virol 2015;87:1899-903. https://doi.org/10.1002/jmv.24243.

[10] D C, Jp A. Transfusion-transmitted hepatitis B virus infection. J Hepatol 2009;51:798-809. https://doi.org/10.1016/j.jhep.2009.05.020.

[11] Miletić M, Bingulac-Popović J, Stojić Vidović M, Hećimović A, Berendika M, Babić I, Đogić V, Samardžija M, Barišić K, Jukić I, Mihaljević I. Anti-HBc prevalence among Croatian blood donors in a 14-year period (2004-2017): Assessment of trends, risks and need for implementing routine testing. Transfus Clin Biol J Soc Francaise Transfus Sang 2019;26:257-62. https://doi.org/10.1016/j.tracli.2019.05.001.

[12] Yang S, Wang D, Zhang Y, Yu C, Ren J, Xu K, Deng M, Tian G, Ding C, Cao Q, Li Y, Chen P, Xie T, Wang C, Wang B, Yao J, Threapleton D, Mao C, Ruan B, Li L. Transmission of Hepatitis B and C Virus Infection Through Body Piercing: A Systematic Review and Meta-Analysis. Medicine (Baltimore) 2015;94:e1893. https://doi.org/10.1097/MD.0000000000001893.

[13] Talić Drlje I, Šušak B, Skočibušić S, Tutiš B, Jakovac S, Arapović J. Sociodemographic characteristics, risk factors and genotype distribution of hepatitis C virus in Bosnia and Herzegovina: Single center experience. Clin Epidemiol Glob Health 2025;31:101845. https://doi.org/10.1016/j.cegh.2024.101845.

[14] Kemp L, Clare KE, Brennan PN, Dillon JF. New horizons in hepatitis B and C in the older adult. Age Ageing 2019;48:32-7. https://doi.org/10.1093/ageing/afy170.

[15] Esposito A, Sabia C, Iannone C, Nicoletti GF, Sommese L, Napoli C. Occult Hepatitis Infection in Transfusion Medicine: Screening Policy and Assessment of Current Use of Anti-HBc Testing. Transfus Med Hemotherapy Off Organ Dtsch Ges Transfusionsmedizin Immunhamatologie 2017;44:263-72. https://doi.org/10.1159/000460301.

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Infectious disease

An epidemiological study of dog bites and utilization of anti-rabies vaccine in Al-Anbar governorate

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Keywords

Dog bites • Rabies • Post-exposure prophylaxis • Vaccination adherence • Iraq • Stray dog

Summary

Background. *Dog bites are an important public health problem throughout the world because of the risk of rabies transmission. This study aimed to describe the epidemiological profile of reported dog bite cases in Al-Anbar Governorate and to assess the utilization of anti-rabies vaccination.*
Methods. *We conducted a retrospective surveillance-based study in Al-Anbar Governorate, Iraq, using registered records of dog bite cases reported between 1January 2020 and 31 December 2025. Dog bite records were included in the main analysis. Descriptive statistics, chi-square tests, and binary logistic regression were used to assess factors associated with documented completion of rabies PEP.*
Results. *Among 6,927 registered animal bite records, 5,655 (81.7%) were dog bites. The mean age of patients was 20.6±15.5 years, and 4,434 (78.4%) were male. The highest proportion of cases occurred among individuals aged 10–14 years (22.1%). Stray dogs accounted for 4,603 (66.5%) of all animal bite records. Among dog bite victims, 4,837 (85.5%) initiated PEP, but only 1,377 (24.4%) had documented completion of all four vaccine doses. In multivariable analysis, multiple bites were associated with higher odds of PEP completion, while face and head bites, penetrating surface scratches, and RIG administration were associated with lower odds of documented completion.*
Conclusion. *Dog bites remain a major public health problem in Al-Anbar Governorate, with low documented completion of rabies PEP. Strengthening surveillance, improving follow-up, ensuring vaccine and RIG availability, and implementing One Health rabies prevention strategies are needed.*

Introduction

Dog bites are an important public health problem worldwide, causing considerable morbidity for physical injuries and the risk of infectious complications, including zoonoses [1]. Based on the severity of contact, the World Health Organization (WHO) classifies animal bites into three categories (I-III) and recommends the immediate post-exposure prophylaxis (PEP) for the prevention of rabies infection in exposed individuals [2]. Rabies remains the most severe consequence of dog bites, being almost always fatal after the onset of clinical symptoms, although it is entirely preventable by proper vaccination in time [3]. Dogs are the main reservoir and source of human rabies transmission worldwide [4].
Rabies is still present in many parts of the world, particularly in some parts of the Middle East where canine rabies is still enzootic [5]. Rabies has been recognized in Iraq for many years, but effective control remains a challenge because of weakened surveillance systems, low vaccination coverage of dogs, lack of routine laboratory confirmation, and reliance on ineffective population control measures such as culling, which disrupt long-term rabies control [6].
Dog bites are of public health importance, but epidemiological data on dog bites in Iraq are scarce due to the lack of systematic monitoring in the Iraqi provinces. This lack of surveillance data limits the ability to effectively evaluate the effectiveness of preventive measures and assess regional differences in exposure patterns [7]. Therefore, a strengthened surveillance system is an important epidemiological indicator to estimate the ongoing risk of transmission of rabies virus and to assess the need for post-exposure prophylaxis (PEP) [8].
The World Health Organization, in collaboration with the Global Alliance for Rabies Control, has set a target at the global level to eliminate dog-mediated human rabies by 2030 through a coordinated One Health approach involving human health care, animal vaccination programs, and methods for managing dog populations. This can be achieved only by improving surveillance systems and using vaccines optimally [9].
Al-Anbar Governorate is one of the largest in Iraq. There are no specific epidemiological studies on dog bites and the use of anti-rabies vaccination in exposed individuals. The aim of the study was to assess the utilization of anti-rabies vaccination among dog bite victims and to describe the epidemiological profile of reported dog bite cases in Al-Anbar Governorate. Specifically, the study described demographic characteristics, circumstances of exposure, and time trends and measured the proportion of people who initiated and completed the recommended PEP regimen.

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Methods

Study design and setting

A retrospective surveillance-based study was conducted in Al Anbar Governorate, Iraq, using registered dog bite cases reported between 1 January 2020 and 31 December 2025. This study was reported in accordance with the STROBE guidelines for observational studies, and the completed STROBE checklist is provided as supplementary material (Tab. S1).

Data source and study population

Data were obtained from the Al-Anbar Health Directorate's records, specifically from the Public Health Department, Communicable Diseases Division, and Zoonotic Diseases Unit, which uses a standardized surveillance form to collect primary information from hospitals and primary health care institutions across Al-Anbar Governorate.

All registered animal bite cases from 1 January 2020 to 31 December 2025 were reviewed. No sample size calculation was performed because all eligible surveillance records available during the study period were included. Dog bite cases were included in the main analysis to determine the epidemiology of dog bites and the use of anti-rabies vaccination. Cases involving other animals were included only to describe the overall distribution of animal exposures.

Some cases were excluded from specific statistical analyses because critical information required for these analyses was missing or inconsistent. The surveillance records for 2025 included all registered cases reported between 1 January and 31 December 2025; therefore, annual data for 2025 were complete.

Operational definition and variables

Throughout the study period, an animal bite was defined as any documented bite recorded in the official registers for individuals of all ages. The biting animal was classified based on registry records as owned dogs, stray dogs, or other animals [10].

The study variables included age, sex, residence, exposure site (head/face, upper limb, lower limb, trunk, or multiple sites), type of biting animal, and injury severity.

Clinical records categorized the severity of exposure into superficial scratches or abrasions, superficial bite wounds, and deep bite wounds. In addition, the interval between the date of the bite and the initiation of anti-rabies vaccination was recorded.

Post-exposure prophylaxis (PEP) variables included the administration of the rabies vaccine; the vaccination schedule used (Zagreb regimen: two doses on day 0, followed by single doses on days 7 and 21); the total number of vaccination doses administered in accordance with the schedule; and recorded administration of rabies immunoglobulin (RIG).

In this study, completion of anti-rabies vaccination (ARV) was defined as cases that received all four vaccine doses according to the prescribed schedule, whereas incomplete ARV was defined as receiving fewer than the full four-dose regimen [11]. Completion status was assessed using all registered dog bite records. Cases were classified as completed when documentation showed receipt of all four doses of the Zagreb regimen. Records lacking documentation of four doses were classified as incomplete.

Missing information

Missing information was present in several variables. Vaccination status was unknown in 773 cases (13.7%), RIG status in 695 cases (12.3%), and occupation in 1660 cases (29.4%). In addition, 980 records were excluded from the analysis of the interval between exposure and initiation of PEP because of missing or inconsistent dates. Analyses were conducted using available data only, and no imputation procedures were performed. No registered records were available for 2021 because surveillance reports for that year were missing from the archived database. Potential information bias was assessed by describing the extent of missing data and by excluding records with unknown or missing values from the multivariable regression analysis.

Statistical Data Analysis

Collected data were coded, entered, presented, and analyzed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). The data were presented by using descriptive statistics such as frequencies, percentages, means and standard deviation.

The chi-square test was used to assess the association between categorical variables and completion of post exposure prophylaxis. Statistical significance was considered at $p \leq 0.05$ [12]. Binary logistic regression analysis was performed to identify independent predictors of documented completion of rabies post-exposure prophylaxis. PEP completion was coded as completed versus not completed. Variables considered clinically relevant, including age group, sex, type of dog, anatomical site of bite, bite description, number of bites, and RIG status, were included in the model. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported. Records with missing or unknown values in any model variable were excluded from this analysis.

Results

A total of 6,927 animal bite cases were registered in Al Anbar governorate between 2020 and 2025, which included 5,655 (81.7%) cases of dog bites. The selection of animal bite records included in the study is presented in Figure 1.

Demographic characteristics

Among 5,655 dog bite cases, the mean age of the patient was 20.6±15.5; the most affected age group was 10-14 (22.1%), followed by 5-9 years (17.5%), and the lowest proportion was observed in the 55-59 years group (1.5%). Males constituted the majority of dog bite cases

Tab. I. Demographic characteristics.

Variable	Category	n	Percentage %
Age group (years)	<5 years	405	7.2%
	5-9	988	17.5%
	10-14	1,250	22.1%
	15-19	698	12.3%
	20-24	497	8.8%
	25-29	413	7.3%
	30-34	325	5.7%
	35-39	265	4.7%
	40-44	231	4.1%
	45-49	176	3.1%
	50-54	163	2.9%
	55-59	82	1.5%
	≥60 years	162	2.8%
Mean±SD	20.6±15.5	-	-
Sex	Male	4,434	78.4%
	Female	1,221	21.6%
Occupation	Student	1,843	32.6%
	Unknown	1,660	29.4%
	Unemployed	1,569	27.7%
	Housewife	277	4.9%
	Employee	138	2.4%
	Military	133	2.3%
	Retired	20	0.4%
	Health worker	6	0.1%
	Farmer	9	0.2%
	Total	5,655	100%

Tab. II. Spatial and temporal distribution.

Variable	Category	n	Percentage %
District	Al Fallujah	2,287	40.5%
	Al Ramadi	1,032	18.2%
	Al Qaim	860	15.2%
	Heet	290	5.1%
	Al Amiriyah	313	5.5%
	Al Karma	284	5.0%
	Haditha	138	2.4%
	Anah	99	1.8%
	Rawah	58	1.1%
	Al Khalidiyah	116	2.1%
	Al Rutbah	98	1.7%
	Al Baghdadi	61	1.1%
	Al Habbaniyah	19	0.3
Year	2020	243	4.3%
	2022	674	11.9%
	2023	1,275	22.5%
	2024	1,383	24.5%
	2025	2,080	36.8%
Season	Autumn	1,504	26.6%
	Summer	1,488	26.3%
	Spring	1,358	24.0%
	Winter	1,305	23.1%
	Total	5,655	100%

(78.4%), while females accounted for 21.6% (Tab. I). Students represent the largest occupational group (32.6%), followed by cases where their occupation was unknown (29.4%), and health workers were the lowest proportion (0.1%).

Spatial and temporal distribution

Table II demonstrates the highest proportion of dog bite cases was reported in Al Fallujah district (40.5%) followed by Al Ramadi (18.2%) and the lowest proportion was observed in Al Habbaniyah (0.3%).

The annual distribution of the cases showed a marked increase of the bites over time, with the highest number of bites recorded in 2025 (36.8%) and the lowest in 2020 (4.3%). In the year 2021, there were no registrations, according to records. The annual distribution of dog bite cases is shown in Figure 2.

Seasonally, the highest proportion was observed in autumn (26.6%), followed by summer (26.3%), and the lowest in winter (23.1%). The monthly distribution of dog bite cases is shown in Figure 3.

Characteristics of bites

Table III shows the distribution of all registered animal bite records according to the type of biting animal. Dog bites represented the majority of records, accounting for 5,655 cases (81.7%), and these dog bite records were used for the main analysis of epidemiological characteristics and rabies PEP utilization.

Table IV shows that the anatomical site of the bite was the lower limbs in more than half of the cases (54.3%), followed by the upper limbs (33.1%) and the genitals in the lowest percentage (0.3%).

The description of bites according to records shows that more than half of the cases, 54.3%, suffered from superficial scratches, followed by penetrating surface scratches, 18.4%, and penetrating wounds, 14%, while the lowest percentage, 13.3%, were superficial wounds.

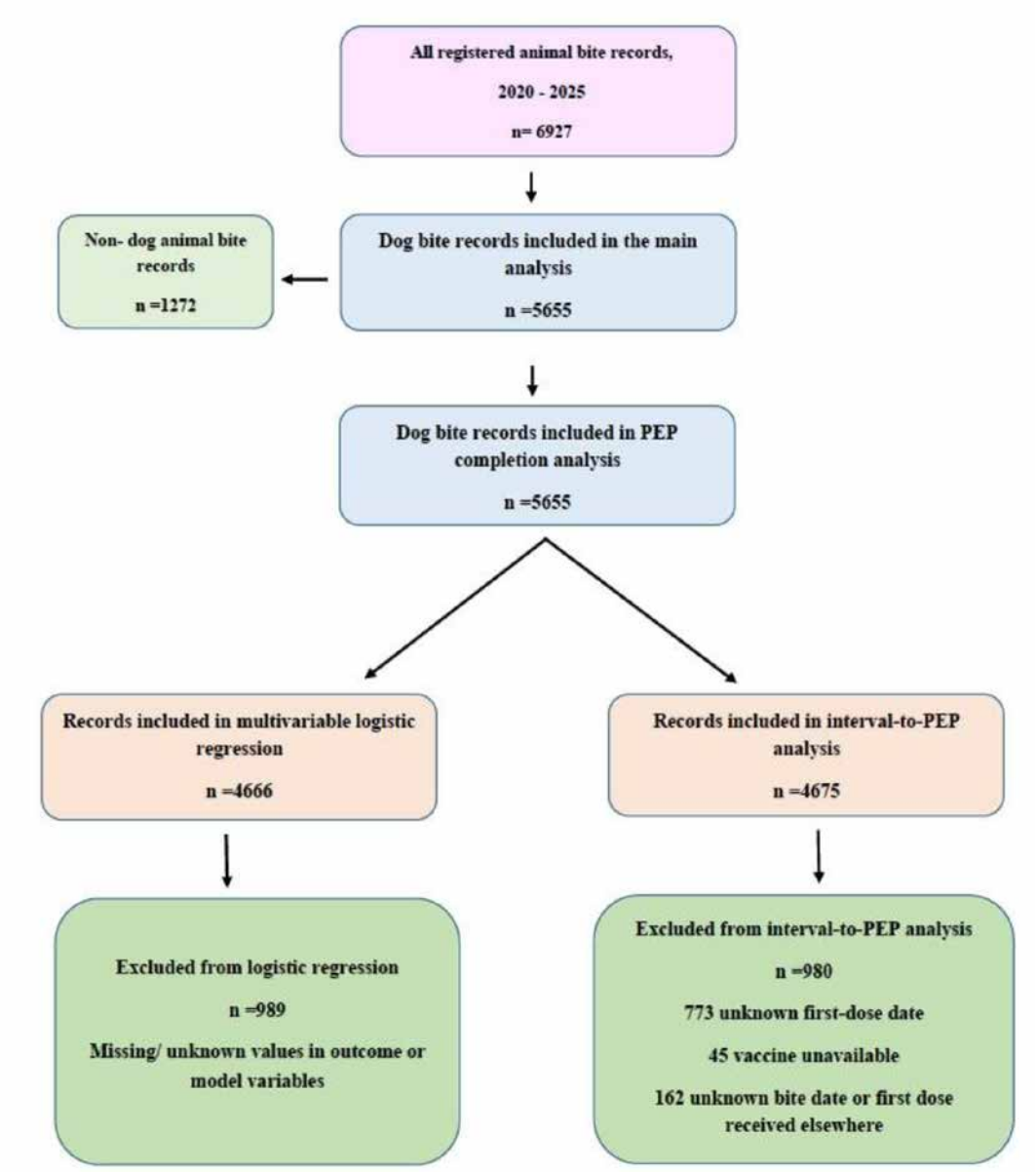
Out of 5,655 cases, the most common bite category found was category II (84.2%), and category III was represented by 15.8%. single bites accounted for 77.6% of all bites or wounds, while multiple bites accounted for 22.4%, which represented the lowest percentage.

Post-exposure prophylaxis

Among 5,655 dog bite cases, 4,837 (85.5%) initiated the first dose of PEP, 13.7% had unknown vaccination status, and 0.8% did not receive the vaccine because it was unavailable. More than half of the cases, 55.8%, received rabies immunoglobulin, followed by cases that did not receive RIG (31.9%) and the lowest percentage (12.3%) in cases where their RIG status was unknown.

Among all 5,655 registered dog bite cases, 1,377 (24.4%) were documented as having completed all four doses of the rabies vaccination schedule, while 75.6% did not.

Fig. 1. Flow diagram of animal bite records and dog bite cases included in the study.



Interval between dog bite exposure and starting PEP

Among 4,675 dog bite cases, the majority of cases, 88.5%, began receiving the vaccine on the same day of exposure, followed by 4.6% initiated PEP after one day, whereas 1.0% initiated PEP after 4-7 days. We excluded 980 cases as follows: 773 cases had an unknown first dose date; 45 cases were not vaccinated because the vaccine was unavailable; and 162 cases were excluded due to either an unknown date of the bite or receiving the first dose at another site, as documented in the records.

Factors associated with completion of post-exposure prophylaxis

A statistically significant association was observed between the completion of vaccination and the type of biting animal, the description of bites, and the number of bites; however, no significant association was found with sex or the anatomical site of the bite.

Multivariable logistic regression analysis

In the multivariable logistic regression model, 4,666 dog bite records with complete data were included. Multiple bites were independently associated with higher odds of documented PEP completion compared with singular bites. Bites involving the face and head and penetrating surface scratches were associated with lower odds of completion. RIG administration was also associated with lower odds of documented PEP completion.

Characteristics of rabies-related death during the study period

Three rabies-related deaths were identified during the study period. All three cases were male and involved bites

Fig. 2. Annual distribution of dog bite cases among the study sample (n=5,655).

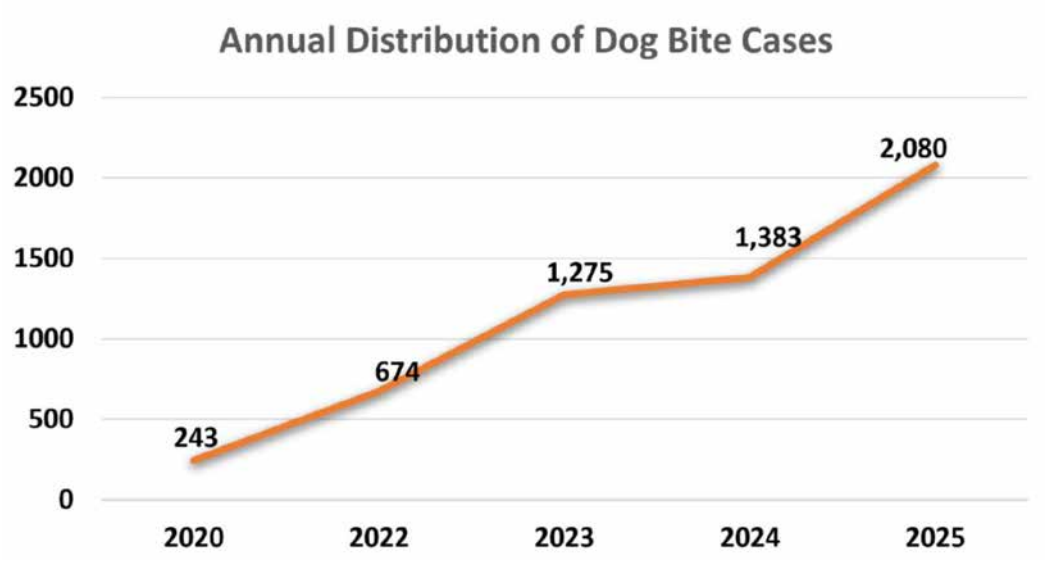
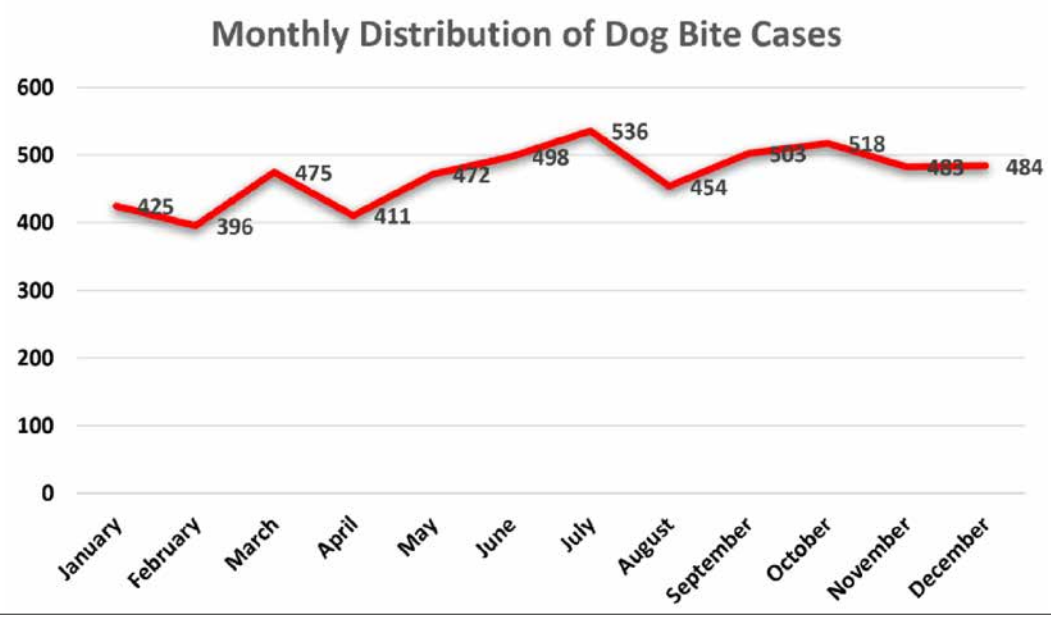


Fig. 3. Monthly distribution of dog bite cases, showing the highest number in July and the lowest number in February.



to the face or head region; two patients did not receive post-exposure prophylaxis, while one patient initiated but did not complete the full vaccination schedule. The diagnosis was based on clinical presentation compatible with rabies and a documented history of dog-bite exposure. Laboratory confirmation was unavailable in the reviewed surveillance records, and information regarding laboratory testing was not documented; therefore, confirmation status could not be verified retrospectively.

Discussion

To the best of our knowledge, this is the first study to describe the epidemiological profile of dog bite cases and rabies post-exposure prophylaxis (PEP) practices in the Al-Anbar governorate, western Iraq. The findings provide baseline data that may support the development of local prevention strategies and allow comparison with other regions and international studies.

Age is an important determinant of dog bite injuries, as nearly half of the victims (46.8%) in this study were under 15 years old, and this observation is consistent with previous studies [13-16]. This may be because children are particularly vulnerable to dog bites due to their spontaneous affection for animals, smaller stature, and lack of awareness about safe interactions.

Males accounted for the majority of dog bite victims. In

Tab. III. Distribution of registered animal bite records by type of biting animal during the study period (n=6,927).

Animal Type	n	Percentage%
Stray dog	4,603	66.5%
Owned dog	1,052	15.2%
Cat	763	11.0%
Other	344	5.0%
Unknown	148	2.1%
Wolf	10	0.1%
Fox	7	0.1%
Total	6,927	100%

This table includes all registered animal bite records. Dog bite records (n=5,655) were included in the main analysis of dog bite epidemiology and rabies PEP utilization. Records involving non-dog animals were presented only to describe the overall distribution of animal exposures.

Tab. IV. Characteristics of bites.

Variable	Category	n	Percentage %
Bite site	Lower limbs	3,070	54.3%
	Upper limbs	1,872	33.1%
	Trunk	250	4.4%
	Multisite	326	5.8%
	Face and head	119	2.1%
	Genitals	18	0.3%
Bite description	Superficial scratches	3,072	54.3%
	Penetrating surface scratches	1,041	18.4%
	Superficial wounds	752	13.3%
	Penetrating wounds	790	14%
WHO exposure category	Category II	4,762	84.2%
	Category III	893	15.8%
Number of bites	Singular	4,387	77.6%
	Multiple	1,268	22.4%
	Total	5,655	100%

Tab. V. Post exposure prophylaxis status.

Variable	Category	n	Percentage %
PEP status	Initiated PEP	4,837	85.5%
	No vaccine (Not available)	45	0.8%
	Unknown vaccination status	773	13.7%
RIG status	Yes	3,156	55.8%
	No	1,804	31.9%
	Unknown	695	12.3%
Dose status	Not completed	4,278	75.6%
	Completed all four doses	1,377	24.4%
	Total	5,655	100%

Tab. VI. Interval between dog bite exposure and starting PEP.

Interval between dog bite exposure and starting PEP	n	Percentage %
On the same day of exposure	4,141	88.5%
After 1 day	216	4.6%
After 2-3 days	119	2.5%
After 4-7 days	45	1%
More than 7 days	154	3.4%
Total	4,675	100%

the current study, dog bites were almost three times more common among males than females, this finding agrees with previous studies [17, 18]. Males may spend more time outdoors, increasing their likelihood of exposure to dogs. However, other research suggests that dogs are more likely to bite women. These differences may reflect socio-cultural and behavioral variations between males and females [19]. Interpretation of occupational patterns should be made cautiously, as occupation was unknown for nearly one-third of records. Students represented the largest occupational group among bite victims, and this finding is consistent with previous research, demonstrating that students engage in more interactive behavior with animals, leading to a higher likelihood of dog bites [20-22]. Students may be more frequently exposed to dogs because of increased outdoor activities and unsafe interactions with animals. The present study is consistent with the literature, as more than half of dog bites occurred in urban areas [23, 24]. This could be related to the distribution and density of the human population in relation to the number of dog bite cases.

The present study showed a positive trend in the number of dog exposures from 2020 to 2025, with no available records in 2021, similar temporal increases have been reported in other studies [25]. Several factors may explain this pattern, including improvements in surveillance and reporting systems, increased healthcare utilization, changes in dog population dynamics, or increased human–dog interactions. However, because the present study was based on surveillance records and was not designed to investigate the causes of temporal changes, no causal explanation can be established. The majority of bites occurred in the autumn and summer. This seasonal pattern may be associated with increased outdoor human activity during warmer months, resulting in more frequent human–dog interactions. Seasonal behavioral changes in dogs, including reproductive activity and aggression, may also contribute to this finding [17, 26]. In the present study, dog attacks occurred in over eighty percent of cases, and more than half (54.3%) affected the lower limbs. Similar results have been reported in previous studies [21, 27]. This pattern may also reflect the local context in Iraq, where dogs are allowed to roam freely, and there is no vaccination program in place. Dog culling campaigns may provide only temporary control and are often ineffective as a long-term strategy. Inadequate dog population control and the free roaming of both stray and owned dogs may increase the risk of dog-related incidents and contribute to public health concerns [6].

The majority of dog bite victims were classified as category II according to the WHO classification. More

Tab. VII. Factors associated with completion of post exposure prophylaxis.

Variable	Category	Completed n (%)	Not completed n (%)	*p-value*
Sex) n=5655)	Male	1,064 (24)	3,370 (76)	0.8231
	Female	313 (25.6)	908 (74.4)	
Site bite(n 5655)	Face and head	27 (22.7)	92 (77.3)	0.083
	Genitals	7 (35)	13 (65)	
	Lower limbs	785 (25.6)	2,285 (74.4)	
	Multisite	81 (24.8)	245 (75.2)	
	Trunk	64 (25.6)	186 (74.4)	
	Upper limbs	414 (22.1)	1,458 (77.9)	
Bite description (n=5655)	Penetrating surface scratch	197 (18.9)	844 (81.1)	0.001*
	Penetrating wound	195 (24.7)	595 (75.3)	
	Superficial scratch	733 (23.9)	2,339 (76.1)	
	Superficial wound	252 (33.5)	500 (66.5)	
Number 0f bites (n=5655)	Multiple	363 (28.6)	905 (71.4)	0.001*
	Singular	1,014 (23.1)	3,373 (76.9)	
Animal type (n=6779)	Cat	160 (21)	603 (79)	0.001*
	Other+	40 (11.1)	321 (88.9)	
	Owned dog	303 (28.8)	749 (71.2)	
	Stray dog	1,074 (23.3)	3,529 (76.7)	

* Significant difference between percentages using Pearson Chi-square test (χ^2-test) at 0.05 level. + Other animals included foxes, wolves and other animals' species. For animal type analysis, records with unknown animal type were excluded; therefore, the denominator was 6,779.

than half of the cases (54.3%) involved superficial scratches and single wounds. These findings are consistent with other studies [12, 18] although inconsistent results have also been reported [19, 28].

Although most dog bite victims received the first dose on the day of exposure, we found that only 24.4% of cases completed all four doses of rabies vaccination, while 75.6% did not. Similar findings have been reported in previous studies, indicating that negligence, lack of awareness, logistical challenges and vaccine unavailability are all factors that may contribute to poor adherence to the vaccination schedule [29, 30]. More than half of the cases received rabies immunoglobulin, and previous studies have reported that this may reflect differences in health care access, awareness, and adherence to WHO recommendations regarding category III exposures [31].

No significant association was observed between gender or bite site and vaccine completion. However, type of animal, bite description, and number of bites were significantly associated with vaccine completion status. Similar findings have been documented in previous studies [30, 32, 33].

In the multivariable logistic regression analysis, multiple bites, anatomical site of injury, bite description, and RIG administration were associated with documented completion of rabies PEP. Victims with multiple bites had higher odds of completing the vaccination schedule, which may be explained by greater perceived severity of exposure and better recognition of the need to complete PEP after more extensive injuries. Previous studies have reported that clinical and exposure-related factors can influence adherence to rabies vaccination schedules [30, 32, 33]. Unexpectedly, bites involving the face and head were associated with lower odds of documented PEP completion. This should not be interpreted as indicating lower clinical importance, as head and face bites are high-risk exposures because of their proximity to the central nervous system; in the present study, all three rabies-related deaths involved bites to the face or head region. This finding may reflect the small number of such injuries, referral of severe cases to other facilities, death before completion of vaccination, or incomplete follow-up documentation. The association between RIG administration and lower odds of PEP completion should not be interpreted causally, as RIG is generally indicated for more severe exposures and routine surveillance records may include documentation or classification errors [2, 31]. Three deaths associated with dog bites were recorded during the study period; all cases were clinically diagnosed without laboratory confirmation. Two patients did not receive PEP and sought medical care only after clinical symptoms appeared; the third patient failed to complete the vaccination schedule because of vaccine unavailability.

The present study had some limitations. First, the retrospective use of surveillance records resulted in incomplete documentation and missing data, particularly for the year 2021. In addition, missing information for some variables, including occupation, vaccination status, and RIG administration, may have introduced information bias and affected the accuracy of certain estimates. Therefore, findings related to these variables should be interpreted with caution. Second, laboratory confirmation of rabies-related deaths was unavailable in the surveillance records reviewed for this study.

Tab. VIII. Multivariable logistic regression analysis of predictors of rabies PEP completion among dog bite victims.

Variable	Category	AOR	95% CI	*p-value*
Age group (years)	<5 years	Reference	----	----
	5-9	0.851	0.626-1.158	0.305
	10-14	0.755	0.558-1.021	0.068
	15-19	0.786	0.566-1.093	0.152
	20-24	0.908	0.641-1.286	0.586
	25-29	0.793	0.547-1.151	0.223
	30-34	0.867	0.584-1.287	0.480
	35-39	0.743	0.492-1.123	0.159
	40-44	0.870	0.562-1.346	0.531
	45-49	0.549	0.326-0.923	0.024*
	50-54	0.767	0.470-1.253	0.290
	55-59	0.894	0.470-1.698	0.731
	≥60 years	1.301	0.805-2.103	0.283
Sex	Female	Reference	----	----
	Male	0.853	0.719-1.011	0.067
Dog type	Stray dog	Reference	----	----
	Owned dog	0.995	0.823-1.203	0.961
Bite site	Lower limbs	Reference	-----	-----
	Face and head	0.468	0.271-0.807	0.006*
	Genitals	0.913	0.287-2.907	0.877
	Multisite	0.880	0.584-1.325	0.540
	Trunk	0.883	0.632-1.232	0.463
	Upper limbs	0.889	0.761-1.038	0.137
Bite description	Superficial scratch	Reference	-----	-----
	Penetrating surface scratch	0.630	0.518-0.788	<0.001*
	Penetrating wound	0.867	0.687-1.095	0.231
	Superficial wound	1.249	1.016-1.535	0.035*
Number of bites	Singular	Reference	-----	-----
	Multiple	1.316	1.089-1.590	0.004*
RIG status	No	Reference	----	----
	Yes	0.777	0.661-0.914	0.002*

AOR: adjusted odds ratio; CI: confidence interval; RIG: rabies immunoglobulin; PEP: post-exposure prophylaxis. The model included 4,666 dog bite records with complete data. Records with missing or unknown values in any model variable were excluded. *Statistically significant at $p \leq 0.05$.

Although findings may not be fully generalizable to all Iraqi governorates because of regional differences in dog populations and healthcare access, the results provide important evidence for rabies prevention strategies in western Iraq.

Conclusion

Dog bites remain an important public health problem in Al-Anbar Governorate, particularly because of the low documented completion rate of rabies PEP despite a high rate of vaccine initiation. The findings highlight the need to improve adherence to the full PEP schedule, ensure continuous availability of rabies vaccine and RIG, strengthen surveillance and documentation systems, and expand public education on rabies prevention. Integrated One Health interventions, including mass dog vaccination and humane management of stray dog populations, are essential to reduce the risk of rabies transmission in Al-Anbar Governorate and Iraq.

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We would like to acknowledge the director of the Al Anbar Health Directorate; the Public Health Department; the Communicable Diseases Division; and, in particular, Muhammad Murtada, head of the Zoonotic Diseases Unit, for providing us with access to the health records and for their dedication and hard work during the study period.

Tab. IX. Characteristics of rabies-related death during study period.

Variable	Case 1	Case 2	Case 3
Year	2023	2024	2025
Cases	1	1	1
Age	8 years	45 years	8 years
Sex	Male	Male	Male
Biting animal	Stray dog	Stray dog	Owned dog
Anatomical site bite	Face	Face	Face and head
Date of bite	Not documented	16/12/2023	5/4/2025
Symptoms onset date	Not documented	5/1/2024	20/5/2025
Interval from bite to symptoms	Approximately 1.5 months, according to the report	20 days	45 days
PEP	Not taken	Not completed	Not taken
Reported clinical manifestations	Dyspnea, hydrophobia, followed by loss of consciousness and death	Dyspnea, hydrophobia, followed by loss of consciousness and death	Dyspnea, hydrophobia, followed by loss of consciousness and death
Basis of diagnosis	Clinical presentation compatible with rabies and history of dog-bite exposure	Clinical presentation compatible with rabies and history of dog-bite exposure	Clinical presentation compatible with rabies and history of dog-bite exposure
Laboratory confirmation	Not available	Not available	Not available
Reason laboratory confirmation was unavailable	Not documented in surveillance records	Not documented in surveillance records	Not documented in surveillance records

Ethical Approval

The study was approved by the Medical Ethics Committee of Middle Technical University, reference number MEC (180). All ethical considerations including patients' confidentiality and privacy of all recorded information were strictly followed before data collection.

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This research received no external funding.

Conflict of interest statement

The authors declare no conflict of interest.

Author contributions

NSJ: conceived and designed the study, collected the data, performed the statistical analysis, interpreted the results, and drafted the manuscript. AHR: supervised the study design, contributed to data interpretation, critically revised the manuscript, and provided scientific guidance throughout the research process. RSS: contributed to the study supervision, reviewed the manuscript, and provided critical intellectual input. All authors read and approved the final manuscript.

References

[1] Apeh D, Nwagbo PO, Ifende VI, Oguche MO, Simon E. Appraisal of dog bite cases in Federal Medical Centre, Umuahia Abia state – Nigeria. Sokoto J Vet Sci 2021;19:14-20. https://doi.org/10.4314/sokjvs.v19i1.2.

[2] Sadasivan A, Singh P, Katre R, Bhadoria AS, Saxena V. A descriptive study on epidemiological profile of patients presenting with animal bites at a rural health facility in Uttarakhand, India. J Family Med Prim Care 2025;14:2007-12. https://doi.org/10.4103/jfmpc.jfmpc_1968_24.

[3] Dougas G, Katerelos P, Chatzianastasiou S, Mellou K. The epidemiology of dog bite injuries in Greece: preliminary results of a surveillance scheme. Hippokratia 2023;27:82-8. https://doi.org/10.1186/s12982-025-00771-8.

[4] Giovannini E, Roccaro M, Peli A, Bianchini S, Bini C, Pelotti S, Fais P. Medico-legal implications of dog bite injuries: A systematic review. Forensic Sci Int 2023;352:111849. https://doi.org/10.1016/j.forsciint.2023.111849.

[5] Amiri S, Maleki Z, Nikbakht HA, Hassanipour S, Salehiniya H, Ghayour AR, Kazemi H, Ghaem H. Epidemiological patterns of animal bites in the Najafabad, center of Iran (2012-2017). Ann Glob Health 2020;86:38. https://doi.org/10.5334/aogh.2776.

[6] Hashim HT, Ramadhan MA, Kadhim MH. Iraqi policies and epidemiology on dog bites and rabies elimination. PAMJ One Health 2021;4(12). https://doi.org/10.11604/pamj-oh.2021.4.12.28640.

[7] Majeed H, Hamed M, Al Salihi K. Incidence of dog bite in Al Muthanna governorate including injuries and its clinical healing in the human. MRVSA 2017;6:13-24. https://doi:10.22428/mrvsa.2307-8073.2016.00632.x.

[8] Hussain MH, Mansour KA, Al-Redah SAA, Abid AJ. Clinicopathological features and phylogenetic analysis of rabies infection in local iraqi breed cattle. Bulg J Vet Med 2025;28:89-104. https://doi.org/10.15547/bjvm.2023-0099.

[9] Wyker B, Gupta M. Emergency department visits for dog bite injuries in Missouri municipalities with and without breed-specific legislation: a propensity score-matched analysis. Front Public Health 2024;12:1354698. https://doi.org/10.3389/fpubh.2024.1354698.

[10] Ngugi JN, Maza AK, Omolo OJ, Obonyo M. Epidemiology and surveillance of human animal-bite injuries and rabies post-exposure prophylaxis, in selected counties in Kenya, 2011-2016. BMC Public Health 2018;18(996). https://doi.org/10.1186/s12889-018-5888-5.

[11] Panda M, Kapoor R. Compliance to post-exposure prophylaxis among animal bite patients – A hospital-based epidemiological study. J Family Med Prim Care 2022;11:6215-20. https://doi.org/10.4103/jfmpc.jfmpc_497_22.

[12] Kisaka S, Makumbi FE, Majalija S, Bangirana A, Thumbi SM. Epidemiology and preclinical management of dog bites among humans in Wakiso and Kampala districts, Uganda: Implications for prevention of dog bites and rabies. PLoS One 2020;15:e0239090. https://doi.org/10.1371/journal.pone.0239090.

[13] Chouhan CS, Raihan A, Mia MM, Banerjee S, Shahriar I, Nath P, Uddin JM, Ehsan MA, Ward MP, Anisur Rahman AKM. Demographic, temporal, and spatial analysis of human animal bite cases in Mymensingh District, Bangladesh. PLoS Negl Trop Dis 2025;19:e0012204. https://doi.org/10.1371/journal.pntd.0012204.

[14] Ifaka J-CK, Sumbu AK, Bahinzi L, Pongo A, Longo-Mbenza B, Thamba CM. Epidemiological Aspects and Compliance with Post-Exposure Prophylaxis of People Bitten by a Dog and Received at the Buanionzi State Health Center in Boma, DR Congo. J Biosci Med (Irvine) 2022;10:258-64. https://doi.org/10.4236/jbm.2022.1011021.

[15] Tiwari HK, Mohanty P, Shirke RG, Kurup AU, Satwik C, Kindo SP, Shigwan R, Wangdi K, Gogoi-Tiwari J, Cunha Silva L, Dürr S. Two-leaves and many bites: Profiling dog-bites and adherence to rabies prophylaxis in tea-estate communities of Udalguri District, Assam, India. PLoS Negl Trop Dis 2025;19:e0013791. https://doi.org/10.1371/journal.pntd.0013791.

[16] Gborie SR, Issahaku GR, Bonful HA, Bandoh DA, Squire J, Ameme DK, Kenu E. Analysis of dog bite surveillance data, Volta Region, Ghana, 2020. Front Trop Dis 2023;4:1096275. https://doi.org/10.3389/fitd.2023.1096275.

[17] Yılmaz S, Delice O, Yılmaz Sİ. Epidemiological characteristics, seasonality, trends of dog bite injuries, and relationship with meteorological data. Ann Agric Environ Med 2023;30:229-34. https://doi.org/10.26444/aaem/162308.

[18] Appavu V, Parthasarathi D, Radhakrishnan S, Gounder CA. Incidence of dog bite injuries and clinical rabies in a tertiary care centre-an observational study. Int J Acad Med Pharm 2025;7:1406-1410. https://doi.org/10.47009/jamp.2025.7.4.267.

[19] Liu Y, Li L, Lyu J, Su C. Epidemiological Study of Outpatients in Rabies Post-Exposure Prophylaxis Clinics – Tianjin Municipality, China, 2020. China CDC Wkly 2021;3:822-4. https://doi.org/10.46234/ccdcw2021.201.

[20] Bay V, Jafari M, Shirzadi MR, Bagheri A, Asl IM. Trend and epidemiological patterns of animal bites in Golestan province (Northern Iran) between 2017 and 2020. PLoS One 2021;16:e0252058. https://doi.org/10.1371/journal.pone.0252058.

[21] Ghazanfarpour H, Pourkhosravani M, FallahLaleh-Zari E, Movahed E. Evaluation of the spatial distribution pattern of animal bites in Southern Iran: implications for public health interventions. BMC Vet Res 2025;21:494. https://doi.org/10.1186/s12917-025-04750-8.

[22] Khoubfekr H, Rahmanian V, Jokar M, Balouchi A, Pourvahed A. Epidemiological Analysis of Cases of Animal Bite Injuries at Rabies Prevention Centers Affiliated with Iranshahr University of Medical Sciences. J Prev Med Hyg 2024;65:E491-8. https://doi.org/10.15167/2421-4248/jpmh2024.65.4.3246.

[23] Kiliç S, Cander Cİ, Zeybek A, Yüksel M. An Analysis of Dog and Cat Bite Cases Attending a Tertiary Care Hospital. Eurasian J Tox 2023;5:32-6. https://doi.org/10.51262/ejtox.1347328.

[24] Qader HK, Lak RT, Mohammed KY. Outcomes of Dog Bite Injuries Presenting to the Emergency Department in Erbil, Iraq. Adv Med J 2025;10:85-91. https://doi.org/10.56056/amj.2025.346.

[25] O'Hara N. Dog bites are increasing in frequency and severity - a sustained effect following the COVID-19 pandemic. J Plast Reconstr Aesthet Surg 2024;95:21-3. https://doi.org/10.1016/j.bjps.2024.05.049.

[26] Saulawa M, Umaru G, Ayobami D, Ibrahim K, Musawa A. Prevalence of dog bite cases in humans and vaccination coverage against rabies in selected parts of Lagos State, Nigeria. J Res Vet Sci 2024;1:7-15. https://doi.org/10.5455/jrvs.20240726112057.

[27] Khan UR, Soomar SM, Ghazi SM, Naeem R, Kerai S, Jamali S. Epidemiological pattern and management of dog bite injuries in Karachi, Pakistan: A cross-sectional study. Injury 2023;54(Suppl 4):110473. https://doi.org/10.1016/j.injury.2022.11.016.

[28] Yathagiri N, Khan AM, Sharma R, Agarwal A, Nengminza Sangma RV. Burden of dog bites and associated healthcare seeking behavior for rabies post-exposure prophylaxis in North and South Shahdara municipal zones of Delhi, India. BMC Public Health 2026;26:171. https://doi.org/10.1186/s12889-025-25860-w.

[29] Fotedar N, Shankariah HR. Compliance with anti-rabies post-exposure prophylaxis among animal bite victims attending anti-rabies clinic of a tertiary care centre in urban Bengaluru. BMC Infect Dis 2026;26:701. https://doi.org/10.1186/s12879-026-12879-6.

[30] Debnath A, Toppo VG, Panwar N, Deori TJ, Khongsit A, Kishore J. Compliance of post-exposure prophylaxis (PEP) following animal bite in Indian population: A systematic review and meta-analysis. J Family Med Prim Care 2025;14:3121-31. https://doi.org/10.4103/jfmpc.jfmpc_1957_24.

[31] Yıldırım AA, Doğan A, Kurt C, Çetinkol Y. Evaluation of Our Rabies Prevention Practices: Is Our Approach Correct? Iran J Public Health 2022;51:2128-34. https://doi.org/10.18502/ijph.v51i9.10568.

[32] Zhang W, Guo Y, She F, Liu S, Du X, Liu H. Analysis of Factors Influencing the Course of Rabies Vaccinations: One Year Study on Compliance of Rabies Vaccination Regimens in Haidian District of Beijing. Patient Prefer Adherence 2022;16:2913-20. https://doi.org/10.2147/PPA.S378999.

[33] Lu R, Lin J, Zhou Y, Chen Q, Fan Z, Wu S, Qin P, Li L. Rabies vaccination adherence and associated factors among rabies-exposed patients in Shenzhen, China: A hospital-based cross-sectional study. Epidemiol Infect 2024;152:e15. https://doi.org/10.1017/S0950268824000049.

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Supplementary material

Tab. S1. STROBE checklist.

Item No.	STROBE item	Recommendation	Reported in manuscript / location	Status
1	Title and abstract	Indicate the study design with a commonly used term in the title or abstract; provide an informative and balanced summary	Abstract: Methods identifies a retrospective surveillance-based study; Abstract summarizes background, methods, results, and conclusion	Reported
2	Background/rationale	Explain the scientific background and rationale for the investigation	Introduction: public health importance of dog bites/rabies, need for surveillance data in Iraq and Al-Anbar	Reported
3	Objectives	State specific objectives, including any prespecified hypotheses	End of Introduction: describes aim to assess anti-rabies vaccination utilization and epidemiological profile; specific objectives listed	Reported
4	Study design	Present key elements of study design early in the paper	Methods, Study design and setting: retrospective surveillance-based study	Reported
5	Setting	Describe setting, locations, and relevant dates including periods of data collection	Methods, Study design and setting/ Data source: Al-Anbar Governorate, Iraq; records from 1 January 2020 to 31 December 2025	Reported
6	Participants	Give eligibility criteria and sources/ methods of selection of participants	Methods, Data source and study population: all registered animal bite cases reviewed; dog bite cases included in main analysis; other animal exposures described only	Reported
7	Variables	Clearly define outcomes, exposures, predictors, potential confounders, and effect modifiers	Methods, Operational definition and variables: animal type, bite site, injury severity, PEP variables, RIG, and PEP completion definition	Reported
8	Data sources/ measurement	For each variable of interest, give sources of data and details of methods of assessment	Methods, Data source and Operational definition: standardized surveillance forms from hospitals and PHC institutions; registry-based classification	Reported
9	Bias	Describe efforts to address potential sources of bias	Methods, Missing information: extent of missing data described; available-case analyses; complete-case approach for multivariable regression; Discussion limitations mention information bias	Reported
10	Study size	Explain how the study size was arrived at	Methods, Data source and study population: no sample size calculation because all eligible surveillance records during the period were included	Reported
11	Quantitative variables	Explain how quantitative variables were handled in the analyses	Methods/Results: age reported as mean±SD and categorized into age groups; time interval to PEP analyzed in categories	Reported
12a	Statistical methods	Describe all statistical methods, including those used to control for confounding	Methods, Statistical Data Analysis: descriptive statistics, chi-square tests, binary logistic regression, AORs and 95% CIs	Reported
12b	Statistical methods: subgroups/interactions	Describe methods used to examine subgroups and interactions	No formal interaction analyses were reported; subgroup/category analyses were performed using categorical predictors	Not applicable / not performed
12c	Missing data	Explain how missing data were addressed	Methods, Missing information: unknown vaccination, RIG, occupation, missing/ inconsistent dates; no imputation; complete-case regression	Reported
12d	Statistical methods: study design	If applicable, describe analytical methods taking account of sampling strategy	Not applicable; study included all eligible registered surveillance records rather than a sample survey	Not applicable

12e	Sensitivity analyses	Describe any sensitivity analyses	No sensitivity analysis was reported. Denominators and exclusions were clarified for analyses	Not performed
13a	Participants	Report numbers of individuals at each stage of study	Results and Figure 1: 6,927 animal bite records; 5,655 dog bite records; 4,666 included in regression; 4,675 included in interval-to-PEP analysis	Reported
13b	Participants: non-participation	Give reasons for non-participation at each stage	Methods/Results and Figure 1: non-dog bites excluded from main analysis; records excluded from interval analysis and regression due to missing/unknown data	Reported
13c	Flow diagram	Consider use of a flow diagram	Figure 1: Flow diagram of animal bite records and dog bite cases included in the study	Reported
14a	Descriptive data	Give characteristics of study participants and information on exposures and potential confounders	Results Tables 1–5: demographic characteristics, spatial/temporal distribution, animal type, bite characteristics, PEP status	Reported
14b	Missing data in descriptive data	Indicate number of participants with missing data for each variable of interest	Methods Missing information and Tables 3/5/7: unknown animal type, vaccination status, RIG status, occupation, excluded date records	Reported
14c	Follow-up time	Summarize follow-up time where applicable	Not applicable as this is a retrospective registry-based surveillance study without person-time follow-up	Not applicable
15	Outcome data	Report numbers of outcome events or summary measures	Results Table 5: PEP initiation and completion; Table 9: three rabies-related deaths	Reported
16a	Main results	Give unadjusted and, if applicable, confounder-adjusted estimates and precision	Results Tables 7 and 8: chi-square associations and multivariable logistic regression with AORs, 95% CIs, and p-values	Reported
16b	Main results: category boundaries	Report category boundaries when continuous variables were categorized	Tables 1, 6, and 8: age groups and interval-to-PEP categories reported	Reported
16c	Main results: relative/absolute risk	Consider translating relative risk into absolute risk for a meaningful time period	Not applicable; logistic regression reported odds ratios for documented PEP completion	Not applicable
17	Other analyses	Report other analyses done	Results: chi-square tests, multivariable logistic regression, and descriptive presentation of rabies-related deaths	Reported
18	Key results	Summarize key results with reference to study objectives	Discussion: summarizes epidemiology, PEP initiation/completion, logistic regression findings, and rabies-related deaths	Reported
19	Limitations	Discuss limitations, taking into account sources of potential bias or imprecision	Discussion limitations: incomplete surveillance documentation, missing data, no 2021 records, possible information bias, lack of laboratory confirmation, generalizability	Reported
20	Interpretation	Give a cautious overall interpretation considering objectives, limitations, multiplicity, and other evidence	Discussion: compares findings with previous studies and avoids unsupported causal interpretation for temporal increases and regression findings	Reported
21	Generalizability	Discuss generalizability of the study results	Discussion: findings may not be fully generalizable to all Iraqi governorates due to regional differences, but useful for western Iraq	Reported
22	Funding	Give source of funding and role of funders	Funding statement: research received no external funding	Reported

Non communicable disease

Assessing the Association Between Head and Neck Cancers and Electronic Cigarette Use as Compared to Conventional Cigarette Use: Analysis of Results from National Health Interview Survey 2020-2022

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Keywords

Tobacco Smoking • Electronic Cigarette • Squamous Cell Carcinoma of Head and Neck • Laryngeal cancer • Oral Cavity Squamous Cell Carcinoma

Summary

Objectives. *Head and neck cancers (HNC) are major global issues that are associated with tobacco use. The increasing prevalence of electronic cigarettes (e-cigarettes) necessitates exploring their health risks. The aim of the study is to identify the HNC risk associated of e-cigarettes compared to conventional cigarettes.*
Methods. *Data from the National Interview Health Survey (NHIS) from 2020-2022 was analyzed. The diagnosis of HNC was the primary outcome. Exposure included electronic and conventional cigarette use. Regression analysis was used to establish the relationship between both variables.*
Results. *The study included 77,419 individuals, with 409 of whom were diagnosed with HNC. Conventional cigarette use was higher in the HNC group compared to the non-HNC group (46.6% vs. 32.3%, p<0.001) with a higher risk of HNC (OR: 1.583, p<0.001). Subgroup analysis showed elevated risk of developing laryngeal cancer (OR: 11.774), pharyngeal cancer (OR: 2.329), and mouth and tongue cancer (OR: 1.08, p<0.001 for all) with conventional cigarettes. E-cigarette use had a lower prevalence in the HNC group (15%) compared to the non-HNC group (18.4%, p<0.001), but higher odds of having HNC (OR: 1.619, p<0.001), particularly for mouth and tongue cancer (OR: 5.18) and pharyngeal cancer (OR: 1.19, p<0.001 for both).*
Conclusion. *Electronic cigarette use is associated with an increased risk of head and neck cancers, comparable to that of conventional cigarette use. This highlights the need for further research on the long-term effects of e-cigarette use.*

Introduction

Electronic cigarettes (E-cigarettes) are handheld vaping devices that use electricity to aerosolize a nicotine-containing liquid. The use of e-cigarettes among individuals of various age groups is growing rapidly, especially since it is sometimes used to help conventional cigarette smokers stop smoking. This necessitates the investigation of their health-related consequences to regulate their use and limit the increase of health issues, given that the health effects of electronic cigarette use are sparse [1].

Head and neck cancer (HNC) is a broad range of cancers that originate in the head and neck regions, including malignancies of the oral cavity, nasopharynx, oropharynx, larynx, and hypopharynx [2, 3]. More than 90% of head and neck cancers are head and neck squamous cell carcinoma (HNSCC), which develops from the epithelial linings of the oral cavity, hypopharynx, oropharynx, and larynx [4]. HNC accounts for approximately 660,000 new cases and 325,000 deaths yearly, making HNC the seventh most common cancer worldwide [2]. Regarding the epidemiology of HNC in the United States in 2019, there were 10,860 HNC-related deaths and 53,000 new cases. It is anticipated that by 2030, there will be a 30% yearly increase in the overall incidence of HNC [5, 6].

The risk factors for HNC include smoking, alcohol consumption, Epstein-Barr virus (EBV), and human papillomavirus (HPV) infection. Tobacco and alcohol remain the main risk factors, while HPV infection has increasingly contributed to HNC incidence [3,7]. Also, smoking is proposed to be related to increasing mortality rates in a dose-dependent manner, especially when exposure occurs before diagnosis [8].

Cigarette smoking is a known risk factor for the development of laryngeal cancer [9] and oropharyngeal cancer [10]. However, it has been shown in multiple studies that smoking decreases the risk of developing thyroid cancer [11-13]. Data concerning the effect of e-cigarette use on the development of head and neck cancer are still inconclusive, with a notable lack of longitudinal and controlled studies to establish a clear association [14].

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Methods

Study design and population

In this study, we retrospectively analyze data from the National Health Interview Survey (NHIS). NHIS is a wide-scale interview-based survey that aims to collect information related to health and disease from adults residing in the United States [15]. Data from the years 2020, 2021, and 2022 were used in this study to assess the relationship between the occurrence of head and neck cancers and electronic cigarette use and compare them to conventional cigarette use. Subjects who have had any other type of cancer were excluded from this study. Therefore, those who mentioned any type of the following cancers, did not know if they had them, or refused to answer were excluded from the study: colorectal cancer, uterine cancer for females, stomach cancer, skin cancer (melanoma, non-melanoma, or unidentified types), rectal cancer, prostate cancer for males, pancreatic cancer, ovarian cancer for females, melanoma, lymphoma, lung cancer, liver cancer, leukemia, gall bladder cancer, esophageal cancer, colon cancer, cervical cancer for female subjects, breast cancer, brain cancer, bone cancer, blood cancer, bladder cancer, or other cancers (n=77419).

Variables of the study

Dependent variable (outcome)

The occurrence of head and neck cancers (namely thyroid cancer, laryngeal cancer, throat/pharyngeal cancer, mouth, tongue, and lip cancer) is the dependent variable in this study. It was assessed by asking the participants directly if any of the previously named cancers were mentioned to them by a doctor or other healthcare professional. Those who answered "yes" when asked if thyroid, laryngeal, throat/pharyngeal, mouth, tongue, or lip cancers were mentioned were considered to have the respective type of cancer. Only those who answered "yes" to the question "Have you ever been told by a doctor or other health professional that you had... cancer or a malignancy of any kind?" were asked about specific cancer types afterwards. Those who answered with "I don't know", "not ascertained", or refused to answer were excluded from the study population.

Independent variable (exposure of interest)

In this study, electronic cigarette use and conventional cigarette use are considered to be independent variables. These variables were assessed by asking subjects, "Do you now use e-cigarettes or other electronic vaping products every day, some days, or not at all?" and "Do you now smoke cigarettes every day, some days, or not at all?" Anyone who answered with "some days" or "every day" was considered to be a current electronic cigarette and conventional cigarette user.

Demographic and clinical covariates

In this study, we considered demographic covariates like age (collected as a continuous variable), gender, marital status, race, and educational level. Direct questions were used to assess each of the previously mentioned factors. As for clinical factors, we considered the presence of comorbid conditions including hypertension, prediabetes, and diabetes, using the following questions: "Have you ever been told by a doctor or other health professional that you had... hypertension, also called high blood pressure?"; "Has a doctor or other health professional ever told you that you had prediabetes or borderline diabetes?"; and "Has a doctor or other health professional ever told you that you had diabetes?". BMI was calculated and was gathered categorically as either "underweight", "healthy weight", "overweight", "obese", or "unknown". Furthermore, we considered possible confounders that may interfere with the results of the study, like cigar smoking, pipe smoking, and smokeless tobacco. These factors were gathered by asking the participants about the frequency of cigar or pipe smoking and the use of smokeless tobacco. Every day and some day users were considered to be current users.

Statistical analysis

In this paper, the categorical data of the subjects in this study were reported as percentages, and continuous data were reported as medians. The occurrence of any of the previously mentioned head and neck cancers was evaluated among users of electronic cigarettes and conventional cigarettes. Regression analysis was used to control for confounding factors. We used a chi-square test to compare the occurrence of head and neck cancers among users and non-users of both electronic cigarettes and conventional cigarettes.

Results

This study included a total of 77,419 individuals, 409 of whom were diagnosed with head and neck cancers; the other 77,010 were categorized as non-H&N cancer subjects. Table I shows the baseline characteristics of the population in the study. In terms of gender distribution, males constituted 48.8% of the total population, with 39.1% of the head and neck cancer group and 48.9% of the non-head and neck cancer group, having a statistically significant difference between both groups ($p<0.001$). As for the race, the population of our study shows notable diversity. Hispanic racial origins constituted 18.1% of the total population, with a lower percentage among the head and neck cancer group (13.4%, $p<0.001$). Asians and African Americans had a total percentage of 6.4% and 12.3%, with higher rates among the non-head and neck cancer group (6.4% and 12.3%, $p<0.001$). White origins constituted 60.4% of the entire population, with a higher percentage in the head and neck cancer group (73.2%) compared to the non-head and neck cancer group (60.3%, $p<0.001$).

Regarding BMI, 1.6% were classified as underweight, 31.5% were classified as healthy weight, 33.1% were classified as overweight, and 33.8% were classified as

Tab. I. Baseline characteristics of H&N cancer and non-H&N cancer patients.

	Total	H&N cancer	Non-H&N cancer	*p-value*
Number	77419	409	77010	
Gender: male (%)	48.8	39.1	48.9	<0.001
Race				
Hispanic (%)	18.1	13.4	18.1	<0.001
American Indians (%)	1.5	2.6	1.5	
Asian (%)	6.4	4.5	6.4	
African American (%)	12.3	6	12.3	
White (%)	60.4	73.2	60.3	
Other races (%)	1.4	0.4	1.4	
BMI				
Underweight (%)	1.6	1.9	1.6	<0.001
Healthy weight (%)	31.5	26.3	31.5	
Overweight (%)	33.1	31.6	33.8	
Obese (%)	33.8	40.2	33	
History of chronic diseases				
History of HTN (Y, (%))	29.2	49.1	29.1	<0.001
Borderline diabetes (Y, (%))	13.4	20.9	13.4	<0.001
History of DM (Y, (%))	8.7	13.3	8.7	<0.001
History of Smoking				
Conventional cigarettes smoking (%)	32.4	46.6	32.3	<0.001
e-Cigarettes smoking (%)	18.4	15	18.4	<0.001
Smoking cigars (Y, (%))	3.6	3.6	0.8	<0.001
Smoking pipe (Y, (%))	1	0.3	1	<0.001
Receiving smokeless tobacco (Y, (%))	2.2	0.9	2.2	<0.001

obese. Notably, obesity was significantly more prevalent among the head and neck cancer group than the non-head and neck cancer group (40.2% *vs*. 33%, $p<0.001$), and healthy weight was more common in the non-head and neck cancer group (31.5%) compared to the head and neck cancer group (26.3%, $p<0.001$).

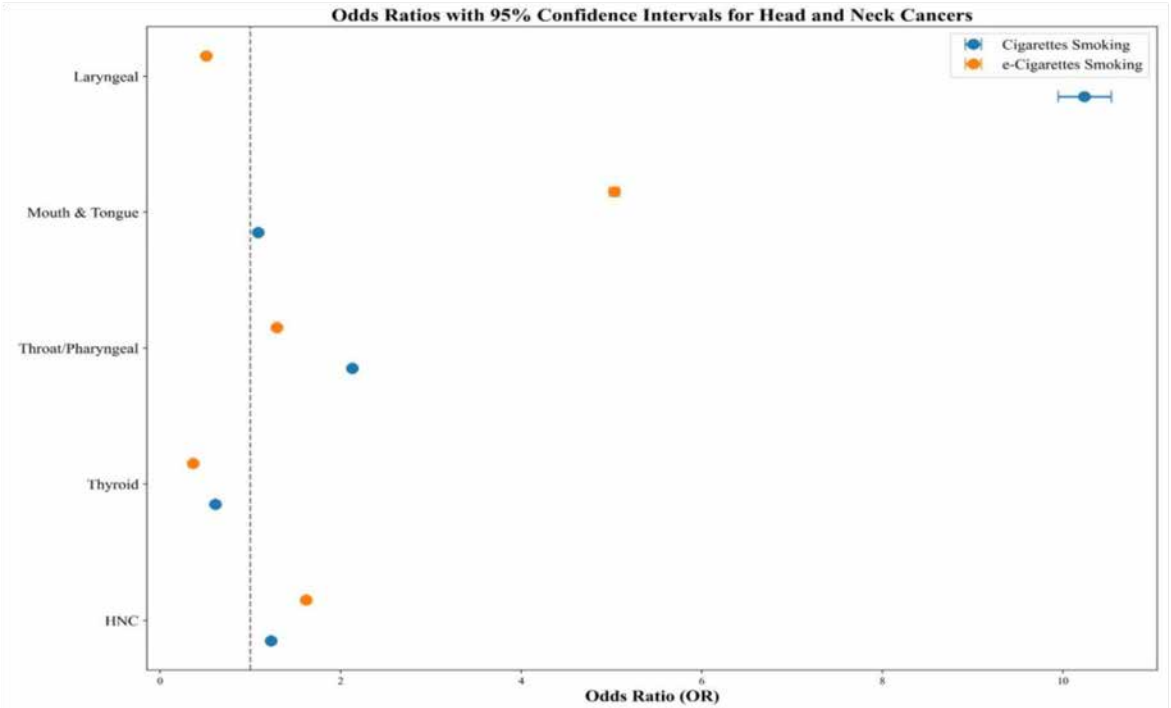
For history of chronic diseases, comorbid conditions were observed to have a higher prevalence among those with head and neck cancers compared to the non-head and neck cancer subjects; these comorbidities include hypertension (49.1% *vs*. 29.1%, $p<0.001$), borderline diabetes (20.9% *vs*. 13.4%, $p<0.001$), and diabetes mellitus (13.3% *vs*. 8.7%, $p<0.001$).

The smoking history of the subjects involved in this study showed that 32.4% of the total population smoked conventional cigarettes, with the percentage being higher among the head and neck cancer patients (46.6%) compared to the non-head and neck cancer subjects (32.2%, $p<0.001$). For e-cigarette use, 18.4% of the entire population reported electronic cigarette use, with a lower percentage of e-cigarette users among the cancer patients compared to the non-cancer subjects (15% *vs*. 18.4%, $p<0.001$).

Figure 1 shows the multivariate analysis after adjustment for age and gender. Conventional cigarette use showed increased risk of overall head and neck cancers, as shown by its odds ratio (OR: 1.23, 95% CI: 1.226-1.23, $p<0.001$). This was similarly evident in e-cigarette use, which also showed increased odds of developing head and neck cancers (OR: 1.619, 95% CI: 1.615-1.622, $p<0.001$). As for thyroid cancer, a decreased risk was shown in both conventional cigarette use (OR: 0.614, 95% CI: 0.611-0.618, $p<0.001$) and electronic cigarette use (OR: 0.367, 95% CI: 0.364-0.37, $p<0.001$). Throat/pharyngeal cancer were associated with an increased risk in both types of smoking, with the odds for conventional cigarette use (OR: 2.13, 95% CI: 2.114-2.145, $p<0.001$) higher than the odds for e-cigarette use (OR: 1.295, 95% CI: 1.283-1.307, $p<0.001$). Regarding oral and tongue cancers, a significant increase in odds of developing the cancer was noted with electronic cigarette use (OR: 5.032, 95% CI: 4.976-5.088, $p<0.001$) compared to conventional cigarette use, which showed a minor increase in odds (OR: 1.087, 95% CI: 1.077-1.098, $p<0.001$). Conversely, the risk of developing laryngeal cancer was largely higher with conventional cigarette use than with e-cigarette use, which showed a lower risk of developing the cancer (OR: 10.239, 95% CI: 9.949-10.537, $p<0.001$) versus (OR: 0.512, 95% CI: 0.496-0.528, $p<0.001$).

Similar trends were observed after adjusting for age, gender, hypertension, and diabetes mellitus (Fig. 2). Overall, head and neck cancer risk was increased in both conventional cigarette use (OR: 1.583, 95% CI: 1.580-1.587, $p<0.001$) and electronic cigarette use (OR: 1.619, 95% CI: 1.615-1.622, $p<0.001$). Thyroid cancer risk was also lower with electronic cigarette use (OR: 0.347, 95% CI: 0.344-0.349, $p<0.001$) and conventional cigarette use (OR: 0.585, 95% CI: 0.582-0.589, $p<0.001$) after adjusting for hypertension and diabetes.

Fig. 1. The likelihood of developing head and neck cancers among conventional cigarette and electronic cigarette use groups after adjusting for age and gender.



Multivariate Analysis

	HNC		Thyroid cancer		Throat/Pharyngeal		Mouth & Tongue		Laryngeal	
	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI
Cigarettes smoking										
Non-smoker	Reference									
Smoker	1.23	1.226-1.23	0.614	0.611-0.618	2.13	2.114-2.145	1.087	1.077-1,098	10.239	9.949-10.537
e-Cigarettes smoking										
Non-smoker	Reference									
Smoker	1.619	1.615-1.622	0.367	0.364-0.37	1.295	1.283-1.307	5.032	4.976-5.088	0.512	0.496-0.528

- Adjusted for age and gender

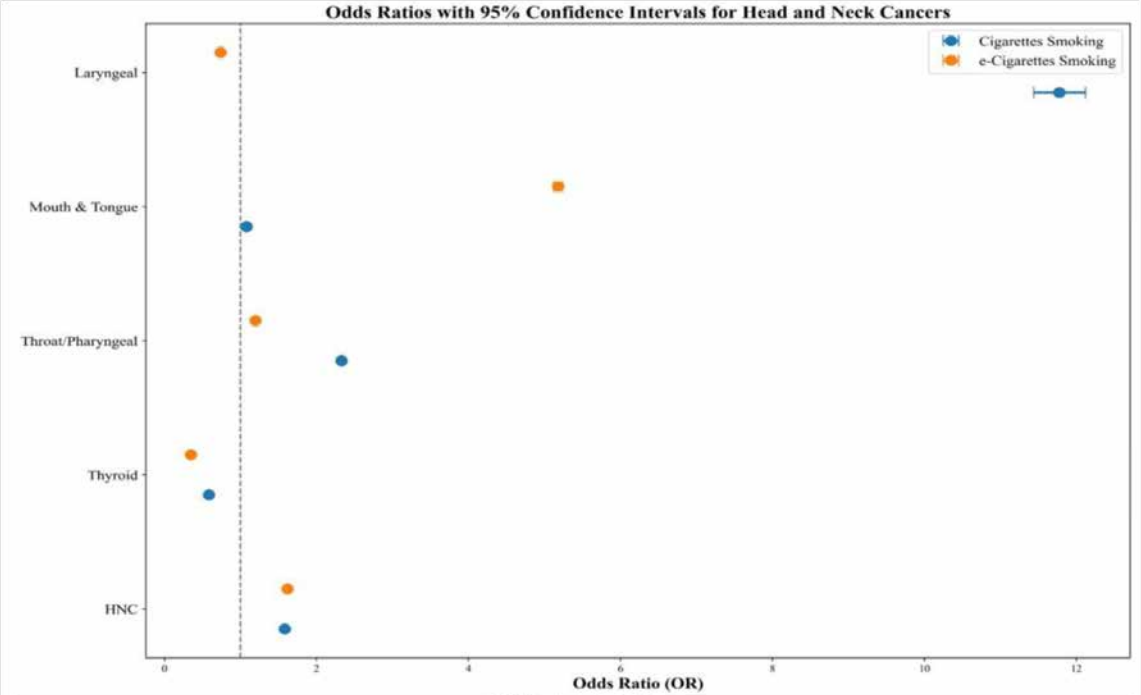
Furthermore, conventional cigarettes exhibited a higher risk for developing throat/pharyngeal cancer (OR: 2.329, 95% CI: 2.312-2.346, $p<0.001$) and laryngeal cancer (OR: 11.774, 95% CI: 11.44-12.118, $p<0.001$) compared to electronic cigarette use (OR: 1.197, 95% CI: 1.185-1.208, $p<0.001$) and (OR: 0.738, 95% CI: 0.715-0.762, $p<0.001$). Mouth and tongue cancer had more odds with electronic cigarette use (OR: 5.18, 95% CI: 5.122-5.239, $p<0.001$) compared to conventional cigarette use (OR: 1.08, 95% CI: 1.07-1.09, $p<0.001$).

Discussion

This study represents a pioneering effort to investigate the risk of head and neck carcinomas (HNCs) among e-cigarettes users versus traditional smokers. Our study utilized the NHIS database and analyzed a cohort of 409 patients diagnosed with HNC. The demographic characteristics of our sample were predominantly female (60.9%), with a high prevalence of obesity (40.2%), hypertension (49.1%), and to a lesser extent DM (13.3%), which may serve as potential confounding factors. These findings resonate with existing literature that indicates DM and HTN have been linked to an increased risk of oral, laryngeal, and esophageal cancers. Also, DM may contribute to more aggressive head and neck tumors due to factors like high blood sugar, insulin resistance, inflammation, and weakened immunity [16, 17]. Furthermore, studies have shown that the combination of hypertension and diabetes significantly increases the risk of these cancers, even in non-smokers [17].

Our study agreed with the current data regarding the correlation between smoking and HN carcinogenesis [18, 19], as the cumulative risk of head and neck carcinoma among cigarette smokers and e-cigarette smokers was shown to be comparable (adjusted odd ratio [aOR]: 1.583, CI 95%: 1.580-1.587 *vs*. aOR: 1.619, CI 95%: 11.615-1.622, respectively). Supporting the positive correlation, the Carolina Head and Neck Cancer

Fig. 2. The likelihood of developing head and neck cancers among conventional cigarette and electronic cigarette use groups after adjusting for age, gender, diabetes mellitus and hypertension.



Multivariate Analysis

	HNC		Thyroid cancer		Throat/Pharyngeal		Mouth & Tongue		Laryngeal	
	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI
Cigarettes smoking										
Non-smoker	Reference									
Smoker	1.583	1.580-1.587	0.585	0.582-0.589	2.329	2.312-2.346	1.08	1.07-1.09	11.774	11.44-12.118
e-Cigarettes smoking										
Non-smoker	Reference									
Smoker	1.619	1.615-1.622	0.347	0.344-0.349	1.197	1.185-1.208	5.18	5.122-5.239	0.738	0.715-0.762

- Adjusted for age, gender, DM and HTN

Study, which includes 1,153 cases, demonstrated that the adjusted OR of current smoking status is 4.16. . The OR was adjusted for sex, race, age, pack-year smoking history, total lifetime alcohol consumption, smokeless tobacco use, family history of cancer, and oral health parameters [20]. The findings of this large-scale study are consistent with those from the International Head and Neck Cancer Epidemiology (INHNCE) consortium, which encompasses 32 control-case studies with over 19,000 HNC cases. The results of the pooled analysis indicated a direct correlation between the frequency of cigarette smoking and HNC risk, with even minimally daily smoking (>0-3 cigarettes per day) being associated with a 50% increase in risk (OR: 1.52, 95% CI: 1.21-1.90). This trend was more evident in laryngeal cancer, where the highest probability was observed among those who smoked >5-10 cigarettes per day [21]. However, these studies do not specifically examine the effect of electronic cigarettes as a potential risk factor for HNC. Our results indicate conventional smoking and e-cigarette smoking have similar odds of increasing the risk of the prevalence of HNC cases, possibly due to various probable carcinogens in e-liquids, including aromatic amino acids, N-nitrosamines, or volatile hydrocarbons. Although these substances are found in lower quantities in e-cigarettes compared to traditional non-filtered cigarettes, their presence could contribute to the increasing likelihood of developing HNCs [22].

Laryngeal cancer is the second most tobacco-related cancer in Europe, following lung cancer, according to GLOBOCAN 2018 data [23]. Cigarette smoking was significantly associated with laryngeal cancer (aOR: 11.77, 95% CI: 11.44-12.11) in our study. This finding came consistent with the Korean National Health Insurance Service database study published in 2022, which confirmed the positive relationship between smoking and laryngeal cancer with an increasing incidence rate among smokers (OR: 3.256, 95% CI: 2.945-3.599, $p<0.0001$) after adjustment of potential confounders [24]. In contrast, our study showed that

e-cigarettes were not associated with a significant risk of laryngeal cancer (aOR: 0.738, 95% CI: 0.71-0.76). In spite of these findings, two systematic reviews of experimental studies have suggested that e-cigarettes may pose a carcinogenic risk for head and neck carcinoma. They concluded that multiple chemical components found in e-cigarettes can cause DNA damage, increase oxidative stress, and induce metaplasia [14, 25]. However, no clinical longitudinal studies have yet examined this association. Surprisingly, our results were not consistent with the current understanding of the association between e-cigarettes and laryngeal cancer.

A population-based cohort study conducted in Japan in 2018 showed a hazard ratio of 2.37 (95% CI 1.51-3.70) among smokers in the risk of increasing incidence of oral cavity and pharyngeal cancer [26]. Our study showed that e-cigarette smoking was associated with increasing odds of oral cavity cancers (aOR: 5.18, 95% CI: 5.12-5.23), with a lesser association observed for conventional cigarette smoking (aOR: 1.08, 95% CI: 1.07-1.09). Our data differ from the findings of the ICARE study based in France, which highlighted that not only smoking status but also the duration contributes to the rising trend of oral cavity cancers [<30 years of smoking; (OR: 3.9, 95% CI: 2.7-5.8), >30 years of smoking; (OR 9.4, 95% CI: 6.3-13.9)] [27]. There is a positive correlation between e-cigarettes and tongue and lip cancers demonstrated in three case reports where e-cigarettes were the exceptional possible incriminating factor for the development of basaloid and invasive squamous cell carcinoma [28, 29].

Regarding pharyngeal and throat cancers, our study showed that both cigarette smoking (aOR: 2.32, 95% CI: 2.312-2.346) and e-cigarette smoking (aOR: 1.19, 95% CI: 1.185-1.208) were associated with the development of the cancer. In a systematic review published in 2015, cigarette smoking was found to be a significant risk factor for different types of head and neck carcinoma, including pharyngeal cancer. This review demonstrated a dose-response relationship, with the risk intensifying with the duration of smoking [1-19 years of smoking (OR: 2.09, 95% CI: 1.08-4.05) *vs*. 20-39 years of smoking (OR: 3.29, 95% CI: 1.18-9.13) *vs*. >40 years of smoking (OR: 6.03, 95% CI: 2.34-15.54)] [30].

Unlike other head and neck carcinomas, thyroid cancer was revealed to be negatively associated with smoking, as demonstrated by a recent meta-analysis done in 2021 by Joon-Hyop Lee et al. (OR: 0.798, 95% CI: 0.681–0.935), corroborating earlier findings from a meta-analysis by Young Ae Cho et al. (2014) [12, 13]. A 2022 cohort study in Korea, included 89,527 patients diagnosed with thyroid cancer. The study illustrated that those who smoke are at a lower risk of developing thyroid cancer compared to those who are nonsmokers (aHR: 0.74, 95% CI: 0.72-0.76) [11]. Our study findings align with the literature, and it showed that both cigarette use (aOR: 0.585, 95% CI: 0.582-0.589) and e-cigarette use (aOR: 0.347, 95% CI: 0.344-0.349) were inversely associated with the odds of thyroid cancer. Although this inverse association may appear counterintuitive, it has been hypothesized that the suppressive effect of smoking on TSH levels thereby reducing the risk of thyroid cancer [31].

Limitations

The potential limitations of this study should be considered when interpreting the results. First, this study is based on a retrospective analysis of cross-sectionally collected information, which, despite being a good method for wide-scale epidemiological studies, cannot establish causality or temporality but rather identify possible association. Furthermore, we relied heavily on self-reported diagnoses of head and neck cancer, which can depend on the level of understanding of the patient himself and the possibility of recall bias. Also, this study analyzes head and neck cancers in general without including the histological subtypes of each cancer in the analysis. Moreover, some possible confounders were not collected by the original questionnaire and therefore were not included in the analysis, which may be related to the development of head and neck cancers.

Conclusion

In conclusion, our analysis has shown a significant association between both electronic cigarette and conventional cigarette use and head and neck cancers, with electronic cigarette use risk being higher than that of the conventional cigarettes. Furthermore, both of them have distinct patterns of cancer risk, with e-cigarettes linked to a higher risk of certain types of cancer, like mouth and tongue cancer, and conventional cigarettes having a broader risk profile, especially for pharyngeal and laryngeal cancer. These findings highlight the necessity for comprehensive preventive and smoking cessation programs. More research is needed to further elucidate the long-term effects of e-cigarette use.

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Ethics approval and consent to participate

This article does not contain studies performed by the authors with human participants or animals. Ethical approval was waived for this study because secondary

data was used from the National Health Interview Survey.

Informed Consent

Informed consent was not required to conduct secondary data analysis of NHIS survey data.

Disclaimer

The content of this research is solely the responsibility of the authors and does not necessarily represent or imply any endorsement, or recommendation by the Centers for Disease Control and Prevention (CDC), the Agency for Toxic Substances and Disease Registry (ATSDR), the Department of Health and Human Services (HHS) or the Unites States Government.

Data Availability

NHIS data are publicly available on the agency website for no charge.

Conflict of interest statement

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Authors' contributions

AMS, ASB, DSA: Conceptualization. AMS: Data curation and Visualization. SA: Formal Analysis. AMS, ABA, SA: Methodology. DSA: Supervision. ZYK, DSA: Writing-Review and Editing. All authors: Writing-Original draft.

References

[1] Breland A, Soule E, Lopez A, Ramôa C, El-Hellani A, Eissenberg T. Electronic cigarettes: what are they and what do they do? Ann N Y Acad Sci 2016;1394:5-30. https://doi.org/10.1111/nyas.12977.

[2] Gormley M, Creaney G, Schache A, Ingarfield K, Conway DI. Reviewing the epidemiology of head and neck cancer: definitions, trends and risk factors. BDJ 2022;233:780-6. https://doi.org/10.1038/s41415-022-5166-x.

[3] Sun Z, Sun X, Chen Z, Du J, Wu Y. Head and neck squamous cell carcinoma: risk factors, molecular alterations, immunology and peptide vaccines. Int J Pept Res Ther 2021;28. https://doi.org/10.1007/s10989-021-10334-5.

[4] Aupérin A. Epidemiology of head and neck cancers: an update. Curr Opin Oncol 2020;32:178-86. https://doi.org/10.1097/cco.0000000000000629.

[5] Thompson-Harvey A, Yetukuri M, Hansen AR, Simpson MC, Adjei Boakye E, Varvares MA, Osazuwa-Peters N. Rising incidence of late-stage head and neck cancer in the United States. Cancer 2020;126:1090-101. https://doi.org/.1002/cncr.32583.

[6] Guo K, Xiao W, Chen X, Zhao Z, Lin Y, Chen G. Epidemiological Trends of Head and Neck Cancer: A Population-Based Study. Biomed Res Int 2021;2021:1-14. https://doi.org/10.1155/2021/1738932.

[7] Rahman QB, Iocca O, Kufta K, Shanti RM. Global burden of head and neck cancer. Oral Maxillofac Surg Clin N Am 2020;32:367-75. https://doi.org/10.1016/j.coms.2020.04.002.

[8] Beynon RA, Lang S, Schimansky S, Penfold CM, Waylen A, Thomas SJ, Pawlita M, Waterboer T, Martin RM, May M, Ness AR. Tobacco smoking and alcohol drinking at diagnosis of head and neck cancer and all-cause mortality: Results from head and neck 5000, a prospective observational cohort of people with head and neck cancer. Int J Cancer 2018;143:1114-27. https://doi.org/10.1002/ijc.31416.

[9] Zuo JingJing ZJ, Tao ZeZhang TZ, Chen Chen CC, Hu Zhang-Wei HZ, Xu YeXing XY, Zheng AnYuan ZA, Guo Yi GY. Characteristics of cigarette smoking without alcohol consumption and laryngeal cancer: overall and time-risk relation. A meta-analysis of observational studies. European Archives of Oto-Rhino-Laryngology 2016;274:1617-31. https://doi.org/10.1007/s00405-016-4390-x.

[10] Bassiony MA, Aqil M, Khalili M, Radosevich JA, Elsabaa HM. Tobacco consumption and oral, pharyngeal and lung cancers. Open Cancer J 2015;8:1-11. https://doi.org/10.2174/1874079001508010001.

[11] Yeo Y, Shin DW, Han K, Kim D, Kim TH, Chun S, Jeong SM, Song YM.Smoking, alcohol consumption, and the risk of thyroid cancer: A Population-Based Korean Cohort Study of 10 million people. Thyroid 2022;32:440-8. https://doi.org/10.1089/thy.2021.0675.

[12] Cho A, Chang Y, Ahn J, Shin H, Ryu S. Cigarette smoking and thyroid cancer risk: a cohort study. Br J Cancer 2018;119:638-45. https://doi.org/10.1038/s41416-018-0224-5.

[13] Lee JH, Chai YJ, Yi KH. Effect of cigarette smoking on thyroid Cancer: Meta-Analysis. Endocrinol Metab (Seoul) 2021;36:590-8. https://doi.org/10.3803/enm.2021.954.

[14] Flach S, Maniam P, Manickavasagam J. E-cigarettes and head and neck cancers: A systematic review of the current literature. Clin Otolaryngol 2019;44:749-56. https://doi.org/10.1111/coa.13384.

[15] Centers for Disease Control and Prevention (CDC). The National Health Interview Survey (NHIS). 2023. Available at: https://www.cdc.gov/nchs/nhis/index.htm. Accessed on: 10/01/2024.

[16] Wang X, Wang H, Zhang T, Cai L, Dai E, He J. Diabetes and its Potential Impact on Head and Neck Oncogenesis. J Cancer 2020;11:583-91. https://doi.org/10.7150/jca.35607.

[17] Seo JH, Kim YD, Park CS, Han KD, Joo YH. Hypertension is associated with oral, laryngeal, and esophageal cancer: a nationwide population-based study. Sci Rep 2020;10:10291. https://doi.org/10.1038/s41598-020-67329-3.

[18] Dhull AK, Atri R, Dhankhar R, Chauhan AK, Kaushal V. Major risk factors in head and neck Cancer: A Retrospective Analysis of 12-Year Experiences. World J Oncol 2018;9:80-4. https://doi.org/10.14740/wjon1104w.

[19] Barsouk A, Aluru JS, Rawla P, Saginala K, Barsouk A. Epidemiology, risk factors, and prevention of head and neck squamous cell carcinoma. Med Sci 2023;11:42. https://doi.org/10.3390/medsci11020042.

[20] Stanford-Moore G, Bradshaw PT, Weissler MC, Zevallos JP, Brennan P, Anantharaman D, Abedi-Ardekani B, Olshan AF. Interaction between known risk factors for head and neck cancer and socioeconomic status: the Carolina Head and Neck Cancer Study. Cancer Causes Control 2018;29:863-73. https://doi.org/10.1007/s10552-018-1062-8.

[21] Berthiller J, Straif K, Agudo A, Ahrens W, Bezerra dos Santos A, Boccia S, Cadoni G, Canova C, Castellsague X, Chen

C, Conway D. Low frequency of cigarette smoking and the risk of head and neck cancer in the INHANCE consortium pooled analysis. Int J Epidemiol 2015;45:835-45. https://doi.org/10.1093/ije/dyv146.

[22] Szukalska M, Szyfter K, Florek E, Rodrigo JP, Rinaldo A, Mäkitie AA, Strojan P, Takes RP, Suárez C, Saba NF, Braakhuis BJ. Electronic Cigarettes and Head and Neck Cancer Risk–Current state of art. Cancers 2020;12:3274. https://doi.org/10.3390/cancers12113274.

[23] Kulhánová I, Forman D, Vignat J, Espina C, Brenner H, Storm HH, Bauld L, Soerjomataram I. Tobacco-related cancers in Europe: The scale of the epidemic in 2018. Eur J Cancer 2020;139:27-36. https://doi.org/10.1016/j.ejca.2020.07.024.

[24] Nam IC, Park JO, Kim CS, Park SJ, Lee DH, Kim HB, Han K, Joo YH. Association of smoking status, duration and amount with the risk of head and neck cancer subtypes: a national population-based study. Am J Cancer Res 2022;12:4815. https://pubmed.ncbi.nlm.nih.gov/36381316/.

[25] Wilson C, Freitas CMT, Awan KH, Ajdaharian J, Geiler J, Thirucenthilvelan P. Adverse effects of E-cigarettes on head, neck, and oral cells: A systematic review. J Oral Pathol Med 2022;51:113-25. https://doi.org/10.1111/jop.13273.

[26] Lu Y, Sobue T, Kitamura T, Matsuse R, Kitamura Y, Matsuo K, Ito H, Oze I, Shimazu T, Yamaji T, Iwasaki M. Cigarette smoking, alcohol drinking, and oral cavity and pharyngeal cancer in the Japanese: a population-based cohort study in Japan. Eur J Cancer Prev 2018;27:171-9. https://doi.org/10.1097/cej.0000000000000283.

[27] Radoï L, Paget-Bailly S, Cyr D, Papadopoulos A, Guida F, Schmaus A, Cenee S, Menvielle G, Carton M, Lapôtre-Ledoux B, Delafosse P. Tobacco smoking, alcohol drinking and risk of oral cavity cancer by subsite. Eur J Cancer Prev 2013;22:268-76. https://doi.org/10.1097/cej.0b013e3283592cce.

[28] Nguyen H, Kitzmiller JP, Nguyen KT, Nguyen CD, Bui TC. Oral Carcinoma Associated with Chronic Use of Electronic Cigarettes. Otolaryngology 2017;7:304. https://doi.org/10.4172/2161-119x.1000304.

[29] Klawinski D, Hanna I, Breslin NK, Katzenstein HM, Indelicato DJ. Vaping the venom: oral cavity cancer in a young adult with extensive electronic cigarette use. Pediatrics 2021;147:e2020022301. https://doi.org/10.1542/peds.2020-022301.

[30] Zhang Y, Wang R, Miao L, Zhu L, Jiang H, Yuan H. Different Levels in Alcohol and Tobacco Consumption in Head and Neck Cancer Patients from 1957 to 2013. PLoS ONE 2015;10:e0124045. https://doi.org/10.1371/journal.pone.0124045.

[31] Czarnywojtek A, Warmuz-Stangierska I, Zdanowska J, Florek E, Zgorzlewicz M, Ruchała M, Stangierski A, Sowiński J. Smoking and thyroid disease--review of literature. Przeglad Lekarski 2009;66:878-81.

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Non communicable disease

Sociodemographic determinants of fruit and vegetable consumption in Indonesia: insights from the 2023 Indonesian Health Survey

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Keywords

Dietary patterns • Health inequities • Health surveys • Noncommunicable diseases • Population health

Summary

Introduction. *Inadequate fruit and vegetable consumption is a recognized risk factor for non-communicable diseases. This study aimed to identify the sociodemographic determinants of fruit and vegetable consumption in Indonesia, which would be fundamental to developing targeted public health interventions for non-communicable diseases.*

Methods. *This cross-sectional study utilized secondary data from the 2023 Indonesian Health Survey. We analyzed the data from 595,303 adults aged 19 years or older, comprising variables of fruit and vegetable consumption and sociodemographic determinants. A logistic regression analysis is conducted to examine associations between sociodemographic factors and fruit and vegetable consumption.*

Results. *A significant majority of Indonesians (97.1%) fail to meet the recommended intake of fruits and vegetables. Better fruit and vegetable consumption patterns were observed among females (aOR=1.31; 95% CI=1.24-1.38), individuals with higher education (aOR=1.47; 95% CI=1.23-1.75), those employed (aOR=1.13; 95% CI=1.06-1.20), married (aOR=1.25; 95% CI=1.16-1.34), from lower economic status groups, and residents of Nusa Tenggara (aOR=1.32; 95% CI=1.13-1.53), Maluku (aOR=1.54; 95% CI=1.16-2.06), Papua (aOR=1.95; 95% CI=1.46-2.60), and rural areas (aOR=1.12; 95% CI=1.02-1.23).*

Conclusion. *Indonesians consume very few fruits and vegetables, and this low consumption isn't uniform. We see significant differences based on factors like gender, education level, occupation, marital status, socioeconomic status, and place of residence. These findings underscore the urgent need for targeted nutritional interventions and the formulation of context-specific public health policies to promote healthier dietary behaviors.*

Introduction

In 2016, non-communicable diseases (NCDs) accounted for 73% of all deaths in Indonesia. The mortality breakdown consisted of 35% from cardiovascular diseases, 12% from cancer, 6% from diabetes mellitus, and 15% from other NCDs [1]. According to the national health survey Indonesian Basic Health Research (Riskesdas), the prevalence of NCDs in Indonesia has increased from 2013 to 2018 [2]. Prevention of risk factors contributing to NCDs must be prioritized in national health strategies to reduce the future prevalence of these diseases [3].

One of the primary risk factors for NCDs is inadequate consumption of fruits and vegetables (2). NCDs such as obesity are caused by unhealthy diets [4]. Changing unhealthy diets to healthy ones can reduce NCDs cases and help people achieve a healthier lifestyle [5]. Regular intake of fruits and vegetables can help reduce the risk of cardiovascular diseases, stroke, and hypertension; prevent certain types of cancer, such as breast, colon, and lung cancer; and protect against neurodegenerative diseases like Alzheimer's and Parkinson's [6]. While these fruits and vegetables-NCDs relationship is established globally, their sociodemographic determinants in Indonesia remain underexplored despite rising NCDs [2] and current low consumption.

Kucuk (2023), in an analysis of the 2019 Turkish Health Survey, reported that fruit and vegetable consumption was positively associated with multiple sociodemographic and lifestyle variables - such as marital status, educational attainment, active behaviors (cycling and walking), adequate rest, higher income, place of residence, age, and total duration of physical activity [7]. While these insights underscore the multifaceted drivers of diet in Turkey, Indonesia's distinct cultural, economic, and geographic diversity may yield different patterns. Context-specific research is therefore indispensable for uncovering Indonesia's unique sociodemographic determinants of fruit and vegetable intake.

As non-communicable diseases continue to rise in Indonesia, and dietary habits shift alongside rapid

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urbanization and income growth, the determinants of fruit and vegetable consumption remain underexplored. Addressing this gap is critical for developing well-targeted public health strategies. Accordingly, the primary objective of this study is to analyze the association between sociodemographic characteristics and fruit and vegetable consumption in Indonesia, using data from the 2023 Indonesian Health Survey (IHS). Specifically, we (1) characterized national patterns of fruit and vegetable consumption and (2) examined how these patterns vary across key sociodemographic subgroups, thereby informing targeted public health interventions.

Methods

Study Design

This study employed a quantitative approach with a cross-sectional design, utilizing secondary data from the 2023 IHS. The IHS – known in Indonesian as Survei Kesehatan Indonesia (SKI) – is a nationally representative health survey conducted by the Indonesian Ministry of Health [8]. The 2023 IHS was selected for this study because it provides the most recent and comprehensive data on individual health status, sociodemographic characteristics, and regional variations. Data collection for the IHS was carried out between August and September 2023.

Participants and Data Collection

The sample for this study consists of individuals aged 19 years and older, drawn from the 2023 IHS dataset. The independent variables include age, gender, education level, employment status, economic status, marital status, place of residence, and area classification. In the IHS dataset, economic status is assessed based on an index of household ownership of durable goods, which is then categorized into five quintiles. The dependent variable in this study is fruit and vegetable consumption. Data on fruit and vegetable consumption were collected using the STEPwise instrument developed by the World Health Organization (WHO) [8]. This study utilized the individual questionnaire from the 2023 IHS, with instruments sourced from both individual and household questionnaires. These were obtained from the official website of the Ministry of Health of the Republic of Indonesia (badankebijakan.kemkes.go.id/hasil-ski-2023/).

The sample included respondents who met the inclusion criteria, which required complete data on all relevant variables. Respondents were categorized into two groups based on their dietary behavior. Those who consumed an adequate amount of fruits and vegetables during the past week were classified as the "healthy group," while those who did not were classified as the "less healthy group." Adequate consumption was defined per WHO-STEPS as the intake of at least five servings of fruits and/or vegetables per day, for seven consecutive days [7, 8]. This WHO-STEPS–based cutoff exceeds Indonesia's Isi Piringku guideline (~3-4 servings/day across three meals) but enables international comparability.

Statistical Analysis

Initial dataset configurations were performed according to the guidelines outlined in the 2023 IHS Data User Manual. This setup included the application of sampling weights, as the IHS 2023 employed a complex sampling design, ensuring that the analytical results are nationally representative. Missing data were identified in the economic status variable (n=46). Given the small proportion relative to the total sample size (n=593,303), these cases were excluded from the analysis. Following data cleaning, variables were categorized according to the study's inclusion criteria.

Descriptive statistical analysis was conducted to summarize the data. Frequencies and percentages were used to describe both independent and dependent variables, with univariate results presented in tabular format. Bivariate analysis was performed using the chi-square test and odds ratios (ORs). The chi-square test assessed the significance of associations between each sociodemographic variable and fruit and vegetable consumption, while ORs measured the strength of these associations. A significance level of $p<0.05$ was used for all bivariate tests.

Multivariable analysis was conducted using logistic regression. Only independent variables that demonstrated statistically significant associations in the bivariate analysis were included in the regression model. This approach was intended to minimize the influence of non-significant variables on the model's outcomes.

Results

As presented in Table I, only 2.9% of respondents met the criteria for a healthy fruit and vegetable consumption pattern. The majority of participants (83.6%) were within the 19-59 age range. The sample was slightly skewed toward ≥ female respondents, with most individuals reporting marital status as married and employment status as employed. Educational attainment was predominantly at the primary level, representing 50.2% of the sample. Economic status was distributed relatively evenly across quintiles. Geographically, the largest proportions of respondents resided in Java (28.5%) and Sumatra (31.0%), with smaller distributions across Sulawesi, Kalimantan, Bali, Nusa Tenggara, Maluku, and Papua.

Bivariate analysis (Tab. II) indicated statistically significant associations between fruit and vegetable consumption patterns and several sociodemographic variables, including gender, educational attainment, employment status, economic status, marital status, place of residence, and area classification. Age did not demonstrate a significant association and was therefore excluded from subsequent multivariable analysis.

Multivariable logistic regression analysis revealed that gender, education level, employment status, economic status, marital status, and regional residence remained

Tab. I. Description of respondents based on diet and sociodemographic characteristics.

Variables	N	%
N	593,303	100.0
Dietary pattern category		
Unhealthy dietary pattern	576,119	97.1*
Healthy dietary pattern	17,184	2.9
Age		
19-59 years	495,964	83.6
≥60 years	97,339	16.4
Gender		
Male	268,591	45.3
Female	324,712	54.7
Education level		
No formal education	30,188	5.1
Primary education	298,020	50.2
Secondary education	192,709	32.5
Higher education	72,386	12.2
Employment status		
Unemployed	196,292	33.1
Employed	397,011	66.9
Economic status		
Lowest	112,041	20.0
Lower-middle	113,283	20.2
Middle	110,865	19.8
Upper-middle	111,938	20.0
Highest	112,030	20.0
Marital status		
Unmarried	124,933	21.1
Married	468,370	78.9
Place of residence		
Jawa	168,918	28.5
Sumatra	183,951	31.0
Kalimantan	56,103	9.5
Sulawesi	88,832	15.0
Bali	13,730	2.3
Nusa Tenggara	36,100	6.1
Maluku	20,283	3.4
Papua	25,386	4.3
Area classification		
Urban	317,614	53.5
Rural	275,689	46.5

Source: IHS 2023. * Based on the WHO-STEPS definition (≥5 servings of fruit and/or vegetables daily for 7 consecutive days). Using the less stringent Isi Piringku benchmark (~3–4 servings/day) would likely result in a lower estimated prevalence of inadequate intake.

significantly associated with healthy dietary patterns after adjusting for potential confounders. Female respondents were 1.31 times more likely to exhibit healthy fruit and vegetable consumption compared to male respondents (95% CI: 1.24-1.38). Higher education was positively associated with healthy dietary behavior, with respondents possessing higher education being 1.47 times more likely to meet recommended intake levels compared to those with no formal education (95% CI: 1.23-1.75). Employment status also showed a positive association, with employed individuals being 1.13 times more likely to consume fruits and vegetables adequately than their unemployed counterparts (95% CI: 1.06-1.20).

Contrary to expectations, higher economic status was inversely associated with healthy fruit and vegetable consumption. Married individuals were 1.25 times more likely to adhere to healthy dietary patterns compared to unmarried individuals (95% CI: 1.16-1.34). Regional analysis indicated that respondents residing in Sulawesi, Nusa Tenggara, Maluku, and Papua were more likely to consume fruits and vegetables adequately compared to those in Java. In contrast, respondents from Sumatra, Kalimantan, and Bali exhibited lower odds of healthy consumption. Additionally, rural residence was associated with a higher likelihood of healthy dietary behavior compared to urban residence (aOR=1.12).

Discussion

The present analysis found that 97.1% of respondents were classified as having inadequate fruit and vegetable intake under the WHO-STEPS definition (≥5 servings/day for 7 consecutive days). This high prevalence reflects the stringency of the operational cutoff, capturing shortfalls relative to an international benchmark, rather than implying an absence of fruit and vegetable consumption. Consequently, the outcome distribution is highly imbalanced (2.9% "healthy"), which is expected when applying a strict criterion in a population with generally low intake. To ensure population-level inference remains valid despite this skewed distribution, all analyses incorporated the IHS 2023 complex survey design and sampling weights, preserving national representativeness of estimated associations and standard errors.

Our findings underscore the necessity for health promotion strategies aimed at increasing fruit and vegetable consumption to be specifically tailored to distinct socio-demographic groups. Key factors warranting consideration for targeted interventions include gender, education level, employment status, economic status, marital status, place of residence, and area classification. Priority for interventions should be given to individuals who are male, possess lower educational attainment, are unemployed, belong to higher economic status groups, are unmarried, reside in regions such as Sumatra, Kalimantan, or Bali, and live in urban areas.

Gender disparities in dietary behavior are particularly salient, with women consistently demonstrating a higher propensity to consume fruits and vegetables compared to men. This observation aligns with previous studies reporting significantly higher intake levels among women across various contexts [7, 9-11]. For instance, Li et al [11] found that women in China consumed more fruit than men, and similar patterns were observed in Turkey, where women exhibited higher fruit and vegetable consumption than their male counterparts [7].

A consistent positive correlation was observed between higher educational attainment and healthier dietary

Tab. II. Results of the Analysis on the Association Between Sociodemographic Factors and Fruit and Vegetable Consumption in Indonesia.

Variables	Fruit and vegetable diet (%)		OR (CI 95%)	aOR (CI 95%)
	Less Healthy	Healthy		
Age				
19-59 years	83.6	83.1	*Reference*	
≥60 years	16.4	16.9	1.07 (1.00-1.14)	
Gender				
Male	45.4	41.6	*Reference*	*Reference*
Female	54.6	58.4	1.23 (1.18-1.30)*	1.31 (1.24-1.38)*
Education level				
No formal education	5.1	3.8	*Reference*	*Reference*
Primary education	50.5	41.9	1.03 (0.88-1.20)	0.99 (0.84-1.15)
Secondary education	32.4	34.5	1.36 (1.16-1.61)*	1.16 (0.98-1.37)
Higher education	12.0	19.8	2.29 (1.93-2.72)*	1.47 (1.23-1.75)*
Employment status				
Unemployed	33.1	31.9	*Reference*	*Reference*
Employed	66.9	68.1	1.06 (1.01-1.11)*	1.13 (1.06-1.20)*
Economic status				
Lowest	19.6	32.9	*Reference*	*Reference*
Lower-middle	20.2	20.9	0.57 (0.52-0.62)*	0.62 (0.56-0.68)*
Middle	19.9	16.4	0.45 (0.41-0.50)*	0.50 (0.46-0.56)*
Upper middle	20.1	15.4	0.44 (0.39-0.48)*	0.49 (0.44-0.54)*
Highest	20.2	14.4	0.42 (0.37-0.47)*	0.45 (0.40-0.51)*
Marital status				
Unmarried	21.2	17.5	*Reference*	*Reference*
Married	78.8	82.5	1.29 (1.20-1.39)*	1.25 (1.16-1.34)*
Place of residence				
Jawa	28.3	32.7	*Reference*	*Reference*
Sumatra	31.2	24.8	0.85 (0.76-0.95)*	0.85 (0.76-0.95)*
Kalimantan	9.5	7.1	0.82 (0.71-0.95)*	0.81 (0.70-0.94)*
Sulawesi	14.9	15.8	1.05 (0.93-1.18)	1.07 (0.95-1.22)
Bali	2.3	2.1	0.93 (0.76-1.14)	0.81 (0.66-0.99)*
Nusa Tenggara	6.0	7.6	1.18 (1.02-1.36)*	1.32 (1.13-1.53)*
Maluku	3.4	4.1	1.43 (1.10-1.90)*	1.54 (1.16-2.06)*
Papua	4.2	5.8	1.95 (1.46-2.60)*	1.95 (1.46-2.60)*
Area Classification				
Urban	53.4	59.1	*Reference*	*Reference*
Rural	46.6	40.9	0.86 (0.79-0.95)*	1.12 (1.02-1.23)*

* *p-value*<0.05. Source: IHS 2023

patterns. This trend is consistent with other research indicating that education level significantly influences fruit and vegetable consumption [7, 12-14]. Consequently, efforts to enhance fruit and vegetable intake could be prioritized at the individual level, targeting those with no formal education, followed sequentially by individuals with primary, secondary, and higher educational backgrounds. Health professionals are further advised to develop health promotion strategies that are specifically tailored to the educational characteristics of their target groups.

Our study also found that unemployed individuals were less likely to consume fruits and vegetables, a result corroborated by previous research [13-15]. Employment status can affect fruit and vegetable intake, as individuals in formal employment often have stable incomes and better access to healthy foods, while unemployed individuals may face financial constraints that limit their ability to purchase such foods [7].

Interestingly, the relationship between economic status and fruit and vegetable consumption in this study diverged from previous findings, which typically report higher intake among wealthier individuals [7, 10, 11]. Here, individuals in the highest economic group consumed fewer fruits and vegetables than those in the lowest economic group. This discrepancy may be explained by the measurement of economic status, which in this study was based on ownership of durable goods rather than actual disposable income. Thus, a materially affluent individual may not necessarily translate to a healthier diet, as intake is influenced by factors beyond purchasing power, such as time constraints, personal preferences, social environment, and lifestyle choices. This inverse association between higher economic

status (as measured by durable goods) and lower fruit/vegetable intake highlights a modern lifestyle trend that warrants further investigation to better understand consumer behavior.

Married individuals exhibited a greater tendency to consume fruits and vegetables compared to their unmarried counterparts, a finding consistent with previous research showing higher intake among married populations [7, 13, 16]. This association may be explained by shared meal routines, spousal encouragement, and household food decisions that support healthier eating patterns. Although these mechanisms were not directly assessed in the present study, they offer a reasonable explanation for the observed relationship.

Geographical disparities in fruit and vegetable consumption were also evident, with regions such as Sulawesi, Nusa Tenggara, Maluku, and Papua demonstrating higher proportions of healthy diets compared to Java. This suggests that less developed areas like Nusa Tenggara and Papua consume more fruits and vegetables than more developed regions such as Sumatra, Kalimantan, and Java [12]. Place of residence influences eating patterns through factors such as access to healthy food, prevailing community habits, and local food availability. These findings emphasize the critical need for context-specific interventions that are tailored to regional and population characteristics. Policymakers should leverage evidence-based data to formulate targeted strategies aimed at reducing dietary disparities across regions and social strata.

Within the framework of the Social Determinants of Health (SDH), sociodemographic factors – including gender, education, occupation, economic status, and geographic location – act as social determinants that can profoundly influence individual health behaviors, such as fruit and vegetable consumption. Discrepancies in sociodemographic characteristics, access to resources, health knowledge, and social environments collectively illustrate how these social determinants contribute to disparities in public health outcomes. Consequently, the findings of this study provide a foundational basis for designing multi-level, equity-oriented intervention strategies.

Given that inadequate fruit and vegetable consumption is a well-established risk factor for NCDs, dedicated attention is required to promote healthier diets across all segments of society. This aligns with recommendations from other studies, which identify the promotion of fruit and vegetable intake as a pivotal strategy in the prevention and control of NCDs.

To foster improved dietary patterns, particularly in terms of fruit and vegetable consumption, multi-level interventions are indispensable. These interventions should encompass educational initiatives, environmental modifications, and supportive public policies. These align with global evidence linking low fruits and vegetables intake to increased NCDs burden [17, 18], justifying targeted interventions for our identified sociodemographic disparities. Such efforts should be implemented gradually, coherently, and sustainably, as recommended by Woodside et al. [19]. By integrating individual, community, and structural approaches, it is anticipated that the prevalence of low fruit and vegetable intake in Indonesia can be minimized, thereby contributing to a healthier and more equitable society.

The study identified a particularly vulnerable group with the lowest fruit and vegetable intake, comprising males, individuals without formal education, the unemployed, those in higher economic strata (as measured by durable goods), unmarried individuals, and residents of Sumatra, Kalimantan, Bali, and urban areas. Their heightened vulnerability stems from limited access, lower motivation, reduced awareness, specific social roles, and insufficient environmental support. Addressing these disparities necessitates robust multi-sectoral collaboration. For instance, the Ministry of Agriculture could facilitate the development of community gardens or affordable fruit stalls. The National Food Agency could provide fresh vegetable packages to low-income families. The Ministry of Manpower and the private sectors could integrate nutrition education into labor programs. The Ministry of Higher Education, Science, and Technology should engage local leaders as change agents in nutrition education. Health promotion campaigns can be bolstered through peer support and the involvement of male role models who actively practice healthy eating, perhaps through culturally sensitive campaigns that resonate with the target demographic.

The government plays a crucial role in supporting fruit and vegetable consumption through price regulations and market governance. To incentivize healthy eating, policies could include subsidizing local horticultural products, taxing highly processed foods, and regulating healthy food distribution in public institutions. These policy interventions are essential to counteract prevailing market trends that often favor inexpensive, calorie-dense, and nutrient-poor foods [20, 21]. Therefore, beyond educational initiatives, policy-driven structural strategies are paramount to ensuring equitable and sustainable health promotion outcomes.

The measurement of economic status using household durable goods ownership in the IHS dataset revealed a counterintuitive association: higher economic status correlated with lower fruit and vegetable consumption. This type of measurement, based on static assets, may not accurately reflect an individual's current, fluid purchasing ability or disposable income for daily dietary choices. This suggests that increased wealth, when assessed by durable goods, does not automatically translate to healthier diets, as intake is influenced by a complex interplay of factors beyond purchasing power, including time constraints, personal preferences, social environment, and modern lifestyle choices. This specific modern lifestyle trend merits further dedicated research to gain a deeper understanding of consumer behavior.

Rising malnutrition rates amplify global concerns of obesity and overweight as a pandemic. These findings suggest that interventions to improve fruit and vegetables consumption should be tailored to the sociodemographic groups identified in this study as having lower intake.

Since eating behavior is influenced by personal motivations, physiological preferences, and socio-cultural factors across all age groups, tailored efforts are needed to meet these diverse needs. For example, visual education and peer support can effectively engage unemployed or single men, while subsidies or community fruit markets may help those with lower incomes. Such focused approaches are crucial to closing consumption gaps among vulnerable populations [22-24].

Finally, observations from Maluku underscore that fruit and vegetable consumption is shaped by a confluence of individual, social, and spatial factors. In rural Maluku, many households possess fruit trees (*e.g.,* mangoes), providing direct and immediate access to fruits [25]. This contrasts with urban areas, where limited land availability reduces local food sources and increases reliance on market purchases. Our findings indicate higher consumption in rural areas, while urban areas showed no significant association. This highlights the imperative to consider spatial and ecological factors in nutrition policies, advocating for initiatives such as supporting urban farming, promoting home gardens, and revitalizing traditional markets to boost fruit and vegetable intake in urban settings.

Based on the observed associations, future interventions should be tailored to the sociodemographic groups identified in the present study, with emphasis on improving access to and awareness of fruit and vegetables consumption among populations at higher risk of inadequate intake.

Conclusion

Overall, 97.1% of Indonesian adults did not meet the WHO-STEPS fruit and vegetable intake threshold (≥5 servings/day for 7 consecutive days). Although this stringent benchmark produces a highly imbalanced classification in a generally low-intake setting, it ensures international comparability and helps identify priority groups for targeted dietary interventions. Promotion and intervention strategies to increase fruit and vegetable consumption should be tailored and designed based on the priority target groups, specifically those with low intake or considered vulnerable. Vulnerable groups include males, individuals aged 19-59 years, those with low education, the unemployed, and unmarried individuals. For example, initiatives may involve encouraging school canteen vendors to provide fruits and vegetables, inviting fruit sellers to offer pre-cut fruit at schools, and conducting outreach programs on the importance of fruit consumption, particularly targeting unmarried men. In addition, advocacy is needed to gain policy support from relevant stakeholders.

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Ethical Approval

This study received ethical approval from the Medical and Health Research Ethics Committee of the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, under permit number KE/FK/0117/EC/2025.

Conflict of interest statement

The authors have no conflicts of interest to report.

Authors' contributions

AA contributed to the study conceptualization, data curation, formal analysis, interpretation of findings, and drafting of the manuscript as part of her postgraduate study. ALR and FMK supervised the study, contributed to the study design and methodology, provided academic guidance throughout the research process, and critically reviewed and revised the manuscript. DNP and AW served as examiners, contributed to methodological and analytical feedback, and critically reviewed the manuscript. All authors read and approved the final version of the manuscript.

References

[1] Noncommunicable Diseases (NCD) Country Profiles 2018. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO. Available at: https://www.who.int/publications/i/item/9789241514620 Accessed on: 29/10/2024.

[2] Directorate General of Disease Prevention and Control, Ministry of Health, Republic of Indonesia. 2023. Annual Report 2022 Prevention and Control of Non-Communicable Diseases (NCDs).

[3] Purnamasari D. The Emergence of Non-communicable Disease in Indonesia. Acta Med Indones 2018;50(4):273-4. Available at: https://actamedindones.org/index.php/ijim/article/view/1028. Accessed on: 24 July 2024.

[4] Neuwald N V., Pearce AL, Adise S, Rolls BJ, Keller KL. Switching between foods: A potential behavioral phenotype of hedonic hunger and increased obesity risk in children. Physiol Behav 2023;270:114312. https://doi.org/10.1016/j.physbeh.2023.114312.

[5] Burke DT, Bennett AE, Hynds P, Priyadarshini A. Identifying Novel Data-Driven Dietary Patterns via Dimensionality Reduction and Associations with Socioeconomic Profile and Health Outcomes in Ireland. Nutrients 2023;15:3256. https://doi.org/10.3390/nu15143256.

[6] Jideani AIO, Silungwe H, Takalani T, Omolola AO, Udeh HO, Anyasi TA. Antioxidant-rich natural fruit and vegetable products and human health. Int J Food Prop 2021;24:41-67. https://doi.org/10.1080/10942912.2020.1866597.

[7] Küçük N, Urak F, Bilgic A, Florkowski WJ, Kiani AK, Özdemir FN. Fruit and vegetable consumption across population segments: evidence from a national household survey. J Heal

Popul Nutr 2023;42:1-20. https://doi.org/10.1186/s41043-023-00382-6.

[8] Badan Kebijakan dan Pembangunan Kesehatan. Survei Kesehatan Indonesia 2023 dalam Angka. Jakarta: Kementerian Kesehatan Republik Indonesia 2023.

[9] Lee-Kwan SH, Moore LV, Blanck HM, Harris DM, Galuska D. Disparities in State-Specific Adult Fruit and Vegetable Consumption - United States, 2015. MMWR Morb Mortal Wkly Rep 2017;66:1241-7. https://doi.org/10.15585/mmwr.mm6645a1.

[10] Hoy MK, Goldman JD, Moshfegh AJ. Differences in fruit and vegetable intake of U.S. adults by sociodemographic characteristics evaluated by two methods. J Food Compos Anal 2017;64:97-103. https://doi.org/10.1016/j.jfca.2017.06.012.

[11] Li L, Ouyang Y, Wang H, Huang F, Wang Y, Zhang J, Su C, Du W, Jia X, Jiang H, Wang Z, Zhang B. Disparities in fresh fruit and vegetable intake by sociodemographic and behavioural factors among adults in China. Public Health Nutr 2022;25:649-56. https://doi.org/10.1017/S1368980020003274.

[12] Darmawan ES, Kusuma D, Permanasari VY, Amir V, Tjandrarini DH, Dharmayanti I. Beyond the Plate: Uncovering Inequalities in Fruit and Vegetable Intake across Indonesian Districts. Nutrients 2023;15:1-13. https://www.mdpi.com/2072-6643/15/9/2160.

[13] Affret A, Severi G, Dow C, Mancini FR, Rey G, Delpierre C, Clavel-Chapelon F, Boutron-Ruault M, Fagherazzi G. Socioeconomic factors associated with an increase in fruit and vegetable consumption: A 12-year study in women from the E3N-EPIC study. Public Health Nutr 2017;21:740-55. https://doi.org/10.1017/S1368980017003196.

[14] Craveiro D, Marques S, Zverinova I, Maca V, Milan S, Chiabai A, Suarez C, Martinez-Juarez P, Jalon SG, Quiroga S, Taylor T. Explaining inequalities in fruit and vegetable intake in Europe: The role of capabilities, opportunities and motivations. Appetite 2021;165:105283. https://doi.org/10.1016/j.appet.2021.105283.

[15] Giacomuzzo B, Ngo MH, Ha TM, Markoni E, Delley M, Götze F, Le NT, Bui TL, Nguyen AD, Pham BD, Brunner TA, Lucas BF. Determinants of the intention to increase vegetable consumption in Vietnam and Switzerland. J Agric Food Res 2024;15:4-8. https://doi.org/10.1016/j.jafr.2024.100998.

[16] Vinther JL, Conklin AI, Wareham NJ, Monsivais P. Marital transitions and associated changes in fruit and vegetable intake: Findings from the population-based prospective EPIC-Norfolk cohort, UK. Soc Sci Med 2016;157:120-6. http://dx.doi.org/10.1016/j.socscimed.2016.04.004.

[17] Smith L, López Sánchez GF, Veronese N, Soysal P, Oh H, Barnett Y, Keyes H, Butler L, Allen P, Kostev K, Jacob L, Shin J.I, Koyanagi A. Fruit and Vegetable Intake and Non-Communicable Diseases among Adults Aged ≥50 Years in Low- and Middle-Income Countries. J Nutr Heal Aging 2022;26:1003-9. https://doi.org/10.1007/s12603-022-1855-z.

[18] Afshin A, Sur PJ, Fay KA, Cornaby L, Ferrara G, Salama JS, Mullany EC, Abate KH, Abbafati C, Abebe Z, Afarideh M, Aggarwal A, Agrawal S, Akinyemiju T, Alahdab F, Bacha U, Bachman VF, Badali H, Badawi A, Bensenor IM, Bernabe E, Biryukov SH, Biadgilign SKK, Cahill LE, Carrero JJ, Cercy KM, Dandona L, Dandona R, Dang AK, Degefa MG, El Sayed Zaki M, Esteghamati A, Esteghamati S, Fanzo J, Farinha CSE, Farvid MS, Farzadfar F, Feigin VL, Fernandes JC, Flor LS, Foigt NA, Forouzanfar MH, Ganji M, Geleijnse JM, Gillum RF, Goulart AC, Grosso G, Guessous I, Hamidi S, Hankey GJ, Harikrishnan S, Hassen HY, Hay SI, Hoang CL, Horino M, Ikeda N, Islami F, Jackson MD, James SL, Johansson L, Jonas JB, Kasaeian A, Khader YS, Khalil IA, Khang YH, Kimokoti RW, Kokubo Y, Kumar GA, Lallukka T, Lopez AD, Lorkowski S, Lotufo PA, Lozano R, Malekzadeh R, März W, Meier T, Melaku YA, Mendoza W, Mensink GBM, Micha R, Miller TR, Mirarefin M, Mohan V, Mokdad AH, Mozaffarian D, Nagel G, Naghavi M, Nguyen CT, Nixon MR, Ong KL, Pereira DM, Poustchi H, Qorbani M, Rai RK, Razo-García C, Rehm CD, Rivera JA, Rodríguez-Ramírez S, Roshandel G, Roth GA, Sanabria J, Sánchez-Pimienta TG, Sartorius B, Schmidhuber J, Schutte AE, Sepanlou SG, Shin MJ, Sorensen RJD, Springmann M, Szponar L, Thorne-Lyman AL, Thrift AG, Touvier M, Tran BX, Tyrovolas S, Ukwaja KN, Ullah I, Uthman OA, Vaezghasemi M, Vasankari TJ, Vollset SE, Vos T, Vu GT, Vu LG, Weiderpass E, Werdecker A, Wijeratne T, Willett WC, Wu JH, Xu G, Yonemoto N, Yu C, Murray CJL. Health effects of dietary risks in 195 countries, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet 2019;393:1958-72. http://dx.doi.org/10.1016/ S0140-6736(19)30041-8.

[19] Woodside J V., Nugent AP, Moore RE, McKinley MC. Fruit and vegetable consumption as a preventative strategy for non-communicable diseases. Proc Nutr Soc 2023;186-99. https://doi.org/10.1017/S0029665123002161.

[20] Reeve E, Ravuvu A, Johnson E, Nasiga S, Brewer T, Mounsey S, Thow AM. Scaling up food pricing policies in the Pacific: A guide to action. BMJ Glob Heal 2023;8:8-10. http://dx.doi.org/10.1136/bmjgh-2023-012041.

[21] WHO. Fiscal policies to promote healthy diets: WHO guideline. 2024, pp. 1-24. Available at: https://www.who.int/publications/i/item/9789240091016. Accessed on: 21/08/2024.

[22] Agurs-Collins T, Alvidrez J, ElShourbagy Ferreira S, Evans M, Gibbs K, Kowtha B, Pratt C, Reedy J, Shams-White M, Brown AGM. Perspective: Nutrition Health Disparities Framework: A Model to Advance Health Equity. Adv Nutr 2024;15:100194. https://doi.org/10.1016/j.advnut.2024.100194.

[23] Ciangherotti S, Kevicka, K, Ciangherotti E, Rondinone R. Eating behaviour: Research in Liguria on young, adult and elderly subjects. J Prev Med Hyg 2006;47:26-36. https://doi.org/10.15167/2421-4248/jpmh2006.47.1.13.

[24] Crovetto M, Sepúlveda MJ. Relationship between dietary energy intake, nutritional status and cardiovascular risk in adults from the communes of Quellón and Chonchi, Chiloé, Chile. J Prev Med Hyg 2022;63:E435-E441. https://doi.org/10.15167/2421-4248/jpmh2022.63.3.2486.

[25] Sitepu AE, Pakpahan M, Cicilia SL. The Determinant Impacting Fruit and Vegetable Consumption Among Families in Maluku, Indonesia. Indones J Public Heal 2025;20:70-81. https://doi.org/10.20473/Ijph.v20i1.2025.70-81.

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HEALTH PROMOTION

Adolescent vaccination in Italy: bridging policy, clinical practice and public engagement to improve coverage

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Keywords

Adolescent • Human Papilloma Virus • Meningococcal B • Life immunization Schedule • Vaccination strategies

Summary

Adolescence represents a pivotal phase for immunization, yet vaccine coverage in this population remains suboptimal across Italy, particularly against human papillomavirus (HPV) and meningococcal B (MenB), causing a high morbidity associated with HPV-related cancers and MenB-related invasive disease, respectively. Despite inclusion in national immunization strategies, wide regional disparities persist, partly driven by the fact that MenB vaccination is included in the National Vaccination Prevention Plan (PNPV) for infancy but not for adolescence, leaving its adolescent implementation to regional policies. Moreover, adolescents' transitional care phase, psychological perceptions of invulnerability, and structural barriers contribute to delayed or missed vaccinations. Drawing on recent epidemiological data, the paper examines the epidemiological, institutional, and sociobehavioral factors influencing uptake of key adolescent vaccines and highlights the clinical and public health urgency of strengthening the inclusion of adolescent vaccines within national and regional immunization plans, as a prerequisite for improving HPV and MenB vaccination coverage.

Current strategies, including the 2023–2025 National Vaccination Prevention Plan (PNPV), the "Calendar for Life" and regional best practices emphasize the need for harmonized national policies. Future directions include, among others, integrating MenB into the adolescent PNPV, enhancing vaccine delivery through settings – such as schools and sports medicine programs –, and adopting behavioral science frameworks, including the 5C model, to address vaccine hesitancy.

Nationally coordinated communication campaigns and digital registry systems are critical to ensuring equitable, timely, and comprehensive adolescent immunization.

Introduction

Adolescence is a pivotal developmental stage marked by increasing autonomy, identity formation, and greater social interaction, often accompanied by risk-taking behaviors that can undermine preventive health engagement [1, 2].

Vaccination during adolescence is not only crucial for individual health but also for community protection, given the high frequency of interpersonal interactions in school, sports, and social settings [3]. Despite a strong public health rationale, vaccine uptake among adolescents remains inconsistent, reflecting both systemic and psychosocial barriers. These include limited access to preventive services, inadequate integration of care during the transition from pediatric to adult healthcare providers, and structural issues in vaccine delivery [4, 5].

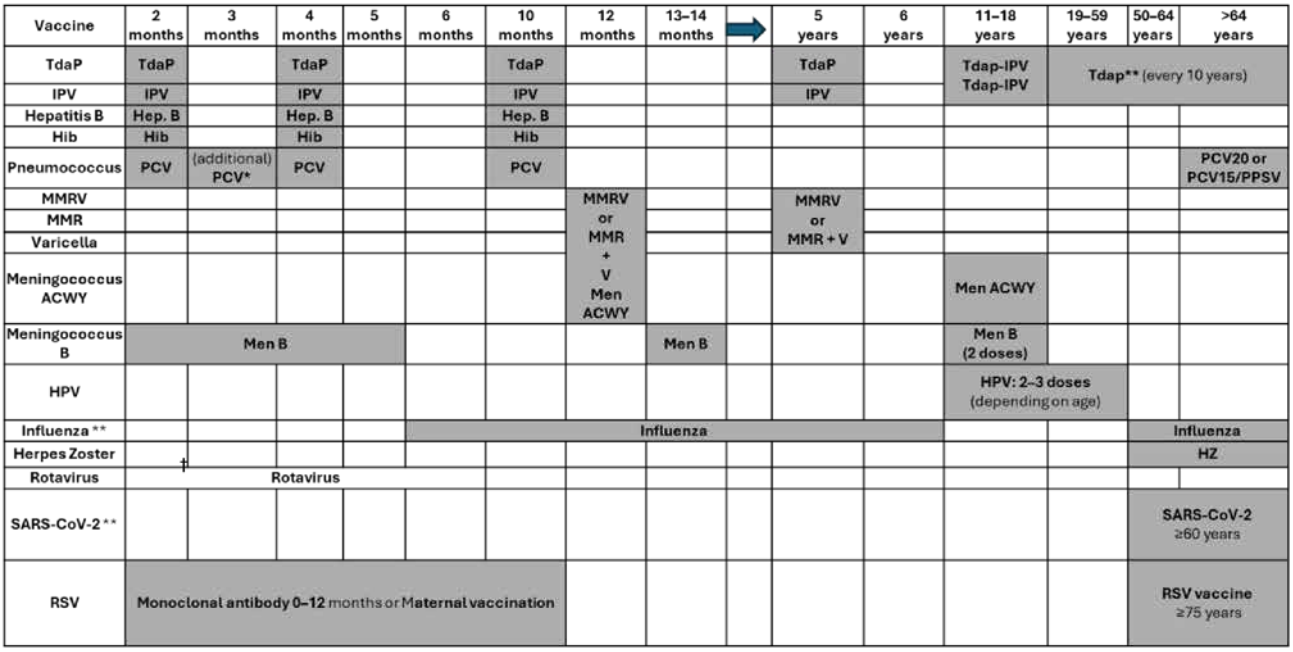
In addition, adolescent's decision-making is influenced by emotional and cognitive drivers, such as a preference for short-term outcomes and a reliance on peer and digital information sources, which may hinder vaccine acceptance [6, 7]. Schools, healthcare professionals, and families are thus essential in shaping attitudes and fostering informed health choices [8]. Strengthening adolescent immunization strategies requires a multifaceted approach, integrating evidence-based communication, supportive health policies, and equitable service delivery to ensure optimal coverage and long-term health outcomes.

Adolescents: a critical phase for immunization

The adolescent life stage presents a strategic opportunity for preventive health interventions, particularly immunization, which plays a dual role: completing primary series missed during childhood and introducing age-specific vaccines such as human papillomavirus (HPV), MenB, and MenACWY [3]. Additional scheduled vaccines in this age group include Tdap (tetanus, diphtheria, and pertussis), MMR (measles, mumps and rubella), varicella, and influenza, with particular attention to catch-up strategies post-COVID-19 disruptions (Fig. 1; Tab. I) [9, 10].

Adolescents are a major reservoir for the transmission of infectious diseases due to their frequent attendance at schools, clubs, and public gatherings [3]. The Delayed

Fig. 1. The Italian "Calendar for Life".



†For adolescents who have been already vaccinated as part of the universal active and free vaccination program in their first year of life (last dose administered within 24 months of age), a new cycle of two dose-schedule, either with the 4-component vaccine or with the 2-component vaccine, is recommended. For adolescents who have already received a cycle of 4-component vaccine (last dose received between 2-10 years of age), they can either receive 1 dose (or 2 doses, depending on regional choices) of the 4-component vaccine, or receive two doses of the 2-component vaccine. * In case of 3+1 PCV20 schedule. ** Vaccine strongly recommended during pregnancy. The calendar refers to vaccination programs aimed at the entire population; this schedule does not take into account the programs targeting at-risk groups or categories. Months and years are considered completed. Examples: the first dose of DTaP-IPV-HBV-Hib can be offered from 2 months of age, or from 61 days of life; the booster dose DTaP-IPV-HBV-Hib at 10 months, or from 301 days of life. Vaccines for which co-administration is strongly recommended are highlighted (yellow) [10].

Tab. I. Adolescent vaccination and booster recommendations according to the Calendar for Life.

Vaccine	Adolescent recommendation	Specific note for previously vaccinated individuals
MenB	Booster dose in adolescence*	Recommended even if vaccinated in infancy due to waning immunity
MenACWY	Booster in adolescence	Maintains protection during high carriage age
HPV	Primary vaccination	Ideally before sexual debut
dTpa	Booster	Reinforcement of waning immunity

* booster dose of the same vaccine received during infancy.

Tab. II. Vaccination coverage among adolescents in Italy for selected vaccines.

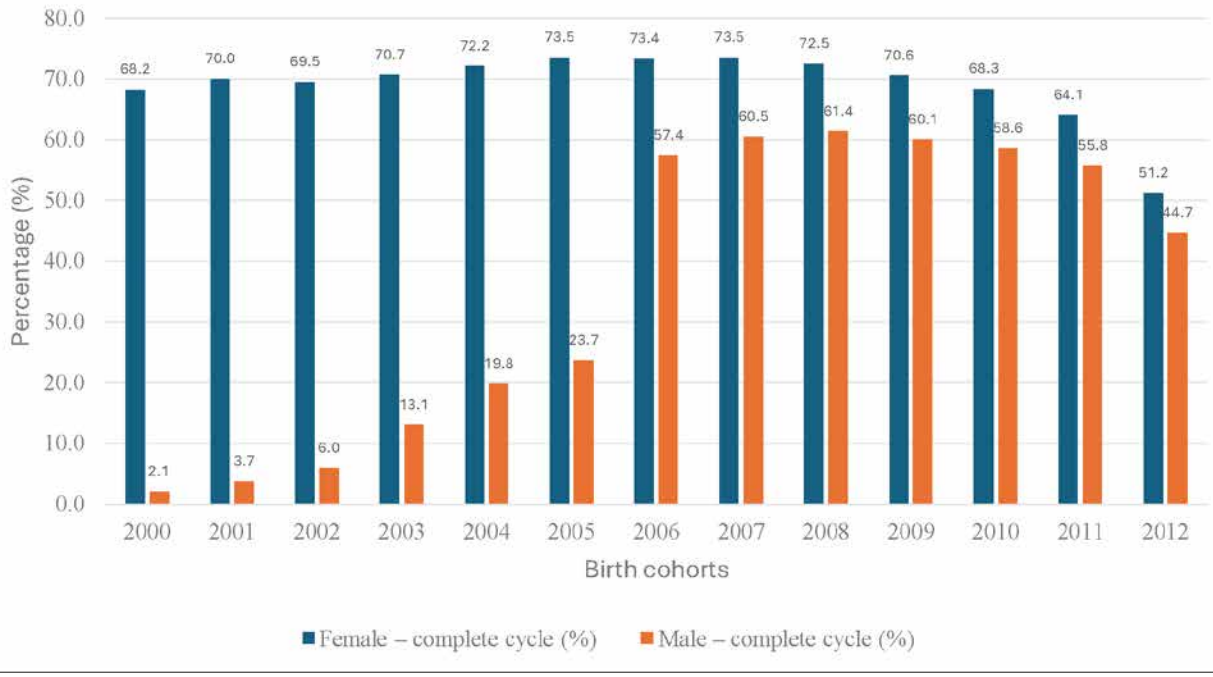
Vaccine	Target age group	National coverage (approx.)	Regional variability	Inclusion in LEA	Key references
HPV (female)	15 years	76.5% (full cycle)	37.8%-82.9%	Yes	[13]
HPV (male)	15–17 years	58.4%	27.9%-78.9%	Yes	[13]
MenB	15-17 years	16.6%*	5.0%–28.3%*	No	[14]
MenACWY	16 years	62.1%	0.2%-89.1%	Yes	[47]
dTpa	16 years	65.4%	25.5%-87.3%	Yes	[47]

* Retrospective administrative database study from a subset of Local Health Units in Veneto, Friuli-Venezia Giulia, Lazio, Liguria and Umbria, representing about 20% of the regional population. Non-naïve adolescents who received a 2-dose schedule during infancy (2009-2011 birth cohorts).

recognition of infections, such as meningococcal disease and HPV, increases the risk of severe health outcomes, including long-term neurological sequelae and cancer [11, 12]. Ensuring high vaccination coverage in this age group not only protects individual health but also strengthens herd immunity, reducing transmission within the broader community [2].

Despite being part of the national vaccination schedule, adolescent vaccination coverage remains low, especially for HPV and MenB vaccines (Tab. II). The completion

Fig. 2. HPV vaccination coverage in Italy by birth cohort and gender. Bars represent the percentage of individuals who completed the full HPV vaccination course, by sex and birth cohort (2000–2012). National data updated to 31 December 2024 (Italian Ministry of Health) [47].



rate for HPV vaccination varies considerably: while some regions achieve coverage rates of up to 80% in females and 75% in males (Lombardy and Umbria), others fall below 60%, far from the national target of 95% (Fig. 2) [13]. MenB vaccination coverage data are lacking the national level. In a retrospective administrative database study from a subset of Local Health Units in 5 Italian regions (Veneto, Friuli-Venezia Giulia, Lazio, Liguria, and Umbria), only 5.0-28.3% of adolescents (2009-2011 birth cohorts) were vaccinated according to a 2 dose-schedule during infancy [14]. Moreover, MenB vaccination coverage is not monitored at national level, leading to the lack of indications for regional target immunization goals to be achieved, which are essential for reaching herd immunity. These disparities are critical, considering that the current National Vaccination Prevention Plan (PNPV 2023-2025) explicitly highlights the need for regional policies to expand adolescent vaccine access [9].

Establishing a dialogue between adolescents and their parents is very complex, because, at this age most adolescents often exhibit a psychological sense of invulnerability and short-term thinking, which reduces their perceived need for preventive health interventions such as vaccination [11, 15]. Moreover, decisions on their health are legally taken by parents who need to be informed in order to promote prevention [11]. Structural and relational barriers further hinder vaccine uptake: these include embarrassment, difficulty accessing services during school hours, and limited trust in adult providers [5]. Autonomy, however, has been identified as a significant enabler; adolescents empowered to make autonomous health decisions show a more positive attitude towards vaccines [6]. Thus, strategies to improve coverage must account for both cognitive-emotional factors and logistical obstacles.

In Italy, adolescents' access to primary care is shaped by a transition in provider roles. Pediatricians follow about 79% of individuals aged 7 to 14 years, focusing on prevention, screening, and scheduled vaccinations [4, 16]. After age 14, most adolescents are seen by general practitioners (GP), often in the context of acute or chronic disease management rather than preventive care [4]. This transition phase is associated with a risk of care discontinuity, especially when preventive measures like vaccinations are not actively addressed by the new provider.

Trusted information sources play a crucial role in shaping adolescents, vaccine decisions. Family, school-based education, sports physicians, and online platforms, especially social media such as TikTok, significantly influence attitudes toward vaccination [2, 7, 8]. Engagement by trusted figures, including teachers, athletes, and healthcare providers, can effectively counteract misinformation [8].

The epidemiological rationale: why HPV and MenB?

Vaccination against MenB and HPV during adolescence is grounded in strong epidemiological evidence highlighting both the clinical burden and public health relevance of these infections. Although MenB disease is relatively rare, its clinical course is often rapid and severe, with a fatality rate between 8-15% even when promptly treated, and up to 60% of survivors experiencing long-term neurological or physical

sequelae [12, 17, 18]. Adolescents and young adults are particularly relevant for transmission, being the age group with the highest carriage rates-up to 5.3 times higher than in other age groups [2, 12]. Moreover, recent data from Italy show that in 2024, among 115 cases of invasive meningococcal disease, serogroup B was the most prevalent across all age groups, accounting for 61 cases and being exclusively detected in children under 10 and persistently found among 15-24-year-olds [19].
In the same period, adolescents aged 15-24 years showed an incidence rate of 0.39 per 100,000, the second highest after infants <1 year (2.36/100,000), reinforcing the need for targeted adolescent immunization strategies [19]. As healthy carriers, adolescents also represent a critical reservoir for community transmission, especially in social settings like schools, dormitories, or nightlife venues, making vaccination not only a personal protection tool but also a public health intervention to reduce overall transmission [3, 12]. Healthy young adults of reproductive age may also represent a significant source of infection for newborns, when asymptomatic carriers [20].
Similarly, HPV infection represents a ubiquitous and often asymptomatic sexually transmitted infection that, while frequently resolving spontaneously, may persist and lead to precancerous lesions and invasive cancers at multiple anatomical sites [21, 22]. Persistent HPV infection is implicated in virtually all cases of cervical cancer and is increasingly recognized in oropharyngeal and anogenital cancers, with an annual global burden of 570,000 cervical cancer cases, including 2,400 in Italy, and a significant proportion caused high-risk HPV genotype 16 and 18 [22-24].
In addition to the oncogenic role, HPV also causes non-malignant conditions such as genital warts, which are common among sexually active adolescents and young adults, especially males [21]. HPV vaccination is unique, alongside HBV, as a cancer-preventing immunization, and its role is central to the WHO's strategy to eliminate cervical cancer by 2030, which includes achieving high vaccination coverage as one of the three pillars [23].
The prevalence of HPV and its asymptomatic nature, combined with the early onset of sexual activity in adolescence, supports the rationale for vaccination at 11-14 years, before potential exposure [11, 25]. The Europe's Beating Cancer Plan and the Italian National Cancer Plan both identify HPV vaccination as a strategic priority, yet current coverage in Italy remains well below the 95% target, with national rates below 70%, and with a high variability in coverage rates for the full cycle observed in the different Italian regions [26, 27].

The institutional framework for adolescent vaccination in Italy: The National Immunization Prevention Plan (PNPV) and the LEA

The National Immunization Prevention Plan (PNPV) represents the primary regulatory and planning instrument guiding immunization policy in Italy [28]. The 2023-2025 edition aims to reduce the burden of vaccine-preventable diseases, including invasive meningococcal disease and HPV-related cancers, through a structured and coordinated national strategy based on scientific evidence and public health priorities [9]. Moreover, the PNPV 2023-2025 explicitly recognizes adolescence as a critical phase for immunization and encourages regions to adopt policies aimed at expanding vaccine access, improving uptake, and reducing inequalities.
The PNPV defines the vaccines included in the Essential Levels of Assistance (LEA), ensuring universal and free access across the country. Within the adolescent age group, HPV vaccination is currently included in the LEA, while MenB vaccination remains excluded. As a result, the implementation of MenB vaccination in this age group is delegated to regional health authorities, leading to heterogeneous access and marked variability in vaccination coverage across Italian regions [2, 12].
In this context, the PNPV serves as the institutional backbone of vaccination policy in Italy, defining mandatory and recommended offers, funding mechanisms, and organizational responsibilities. The PNPV encourages regions to expand their vaccination programs, using the infrastructure and methods developed during the pandemic to improve access and coverage [28], and its effectiveness in the adolescent population depends on regional implementation, the availability of active call–recall systems, and integration with healthcare, educational, and community-based services.

Scientific framework: the Italian "Calendar for Life" and evidence-based recommendations for adolescent vaccination

Alongside the institutional framework defined by the PNPV, adolescent vaccination strategies in Italy are supported by a robust scientific framework represented by the "Calendar for Life" (Calendario per la Vita), a lifetime immunization schedule jointly developed by major Italian public health and scientific societies (Fig. 1). Unlike the PNPV, the Calendar for Life is not a regulatory document but reflects a shared, evidence-based scientific consensus on optimal vaccination strategies across the life course [10].
The Calendar for Life emphasizes that infant-only immunization strategies are insufficient to ensure lifelong protection and strongly supports the role of adolescence as a strategic window for booster and catch-up vaccinations. In this framework, co-administration of vaccines such as MenB, MenACWY, Tdap, and HPV during adolescence is recommended to maximize protection, reduce missed opportunities and improve adherence [10, 26]. A recent the resurgence of measles in Italy, with 529 cases reported by the end of 2025, the administration of a MMR vaccine booster during adolescence represents a valuable strategy to reinforce

immunity and limit onward transmission, particularly to vulnerable populations such as infants [29].
The schedule includes specific indications for both vaccine-naïve adolescents and those previously vaccinated in early childhood (Fig. 1). For meningococcal B vaccination, the Calendar for Life highlights the need for an adolescent booster dose to restore and maintain protective antibody levels in individuals immunized during infancy. Immunological evidence indicates a significant decline in bactericidal antibody titers approximately 7.5 years after completion of the primary series [12]. Furthermore, the activation of the B-cell response requires 5-7 days, underlining the importance of timely booster administration before periods of increased exposure risk [10, 30].
A single booster dose administered during adolescence has been shown to elicit a rapid and robust immune response, with rates ranging from 93% to 100%, consistent with the presence of strong immunological memory [12]. This strategy reduces the number of required doses and healthcare visits, improves cost-effectiveness, and increases the likelihood of completing the vaccination schedule [12, 31].
By defining an ideal, evidence-based immunization pathway, the Calendar for Life complements the institutional framework established by the PNPV. While it does not carry regulatory authority, it provides scientific guidance to support harmonized vaccination strategies, inform regional policies and promote equitable and comprehensive adolescent immunization across Italy [10, 12].

Vaccine policies: what's on the table for adolescents?

The optimal age for adolescent vaccination, particularly between 12 and 14 years, remains a subject of strategic evaluation due to differences in logistical feasibility, immunogenic response, and provider roles. Vaccinating at 12 years aligns with the school calendar and allows paediatricians, who typically follow patients until age 14, to play a proactive role in vaccine counselling and delivery [10]. Co-administration of multiple vaccines, including MenB, MenACWY, DTPa and HPV, is also more feasible in early adolescence, ensuring higher adherence with fewer appointments [31, 32]. Moreover, studies suggest that immunogenicity is robust in this age range, with early administration facilitating timely protection before increased exposure to infection risks [12].
Regarding HPV, the current strategy in Italy falls short of national and European goals. The Europe's Beating Cancer Plan and the Italian Oncologic National Plan aim to eradicate HPV-related cancers, yet coverage remains well below targets [23, 26]. Nationwide, only around 70% of adolescents complete the full HPV vaccination cycle, with a significant drop between the first and second doses [26]. This gap has prompted calls for extraordinary catch-up campaigns and the expansion of vaccination to adult cohorts, at 25 years of age to unvaccinated women during the first cervical screening, and for high-risk groups such as those with HPV lesions or immunocompromised conditions [27].
In this context, extending the adolescent immunization window, integrating vaccine appointments with sports or school activities and leveraging booster doses with co-administration strategies could significantly increase uptake while reducing barriers to access [12, 33]. These policy levers, supported by existing scientific and economic evidence, represent actionable steps toward closing the adolescent vaccination gap in Italy.

The Italian landscape: regional offer and disparities

The current national framework for adolescent vaccination in Italy reflects substantial regional heterogeneity in both policy implementation and coverage outcomes, with the absence of MenB in the national PNPV as a major cause for these regional disparities [23].
Regarding MenB vaccine, 14 regions have introduced active vaccination offers for adolescents. However, only six of these regions extend the offer to non-naïve individuals (with booster dose of the same vaccine received during infancy), thus limiting access for many adolescents at continued clinical risk (Tab. III) [9, 10, 27]. Veneto and Emilia-Romagna stand out for having introduced structured regional programs that actively offer MenB vaccination to adolescents, including clear guidelines on co-administration with other recommended vaccines such as ACWY, dTpa, and HPV. Although precise coverage rates are not always publicly available, both regions are often referenced in national reports as examples of proactive implementation, supported by early communication campaigns and integration with adolescent health services [10, 34, 35]. The higher coverage estimates from some regions reflect proactive local health strategies, including targeted communication and integration of vaccination within broader adolescent health services [12]. Liguria and Lombardia have also provided detailed guidelines for managing non-naïve adolescents, integrating MenB into their adolescent vaccination calendars along with ACWY and HPV vaccines [9, 36, 37].
Similar disparities exist in HPV vaccination coverage, despite being part of the PNPV since 2007. However, some regions serve as models of excellence exemplifying effective integration of vaccination with broader public health strategies. Notable examples of high-performing regions include Lombardia, which is among the Italian regions achieving relatively high adolescent vaccination coverage with first-dose HPV vaccination coverage among 15-year-old girls reaching around 80% [13]. This region has pioneered pharmacy-based vaccination delivery, improving convenience and coverage among adolescents and young adults and, therefore, contributing substantially to overall immunization campaigns (*e.g.,* including influenza, COVID-19, pneumococcus, RSV) [28].
In Trento, health authorities implemented a proactive,

Tab. III. Policy and implementation strategies of adolescent vaccination programs in selected Italian regions.

Region	MenB Offered to Adolescents*	HPV Offered to Adolescents*	Type of immunization registry (*diversity in the software systems and data flows in place.*)	Notable
Veneto	13 years of age (2-dose cycle or booster dose for not naïve and naïve subjects, respectively) co-administered with other age-targeted vaccines.	Girls and boys of 13 years of age. Passive offer on request and active offer to 25-year-old women on their first cervical screening appointment.	Full computerised, same software, individual data real-time.	Active recall [27].
Lombardia	11-18 years of age (2-dose cycle or booster dose for not naïve and naïve subjects, respectively) co-administered with other age-targeted vaccines. Active call at 12 years of age.	Girls and boys up to the age of 26 (2 or 3 dose-schedule depending on age).	Full computerised, different software, individual data real-time.	University Open Days Pharmacy-based HPV campaigns [27].
Trento	14 years of age (active call from 2009 birth cohort). Catch-up for men up to age 30 and women up to age 40 who have not been vaccinated previously.	Girls and boys at 11-14 years of age (catch-up call for naïve young men up to age 30 and naïve young women up to age 40).	Full computerised, different software, individual data real-time.	Screening + gynecology referral for HPV [36].
Tuscany	Active offer to 12 years of age (from 2013 birth cohort) co-administered with other age-targeted vaccines (2-dose cycle or booster dose for not naïve and naïve subjects, respectively)	Girls and boys 10 years of age.	Full computerised, same software, individual data real-time.	Integrated paediatricians into the vaccination system [27]. Network model (meetings with GPs and paediatricians, local media communication, increased opening hours of vaccination clinics and continuous monitoring of vaccination status) [52, 53].
Emilia-Romagna	Active offer to 13 years of age (starting with 2011 birth cohort) as 2-dose cycle or booster dose for not naïve and naïve subjects, respectively) co-administered with other age-targeted vaccines. Offered to 17 years of age (2007 birth cohort) if parents requested and regardless of vaccination status.	Girls and boys at 11-15 years of age (2 or 3 dose-schedule depending on age). Catch-up vaccination for women up to the age of 26, provided by the first cervical cancer screening, and for men at least up to the age of 18 if naïve or have not completed the vaccination cycle.	Full computerised, different software, individual data quarterly.	Active call policies (Regional Act 1045/2019) [54].
Marche	Actively offered free of charge to the cohort of 11-year-olds (born in 2013 or later) in co-administration with the HPV papilloma virus vaccine. A booster is also recommended for not naïve adolescents who received vaccination at 2 years of age (same vaccine used for the primary series).	Girls and boys at 11-18 years of age (2 doses for 11-14 year group and 3 doses for 15-18 years).	Full computerised, same software, aggregate data annually.	Active call policies [31].
Lazio	Years of age.	Girls and boys 11-25 years of age (from 2006 birth cohort)	Full computerised, different software, aggregate data annually.	Active recall systems for MenB and HPV.
Campania	12 years of age, co-administration with tetravalent MenACYW vaccination.	11-48 years of age.	Partially computerised, different software, aggregate data annually.	New digital system, but passive campaigns [39].

Tab. III (*follows*). Policy and implementation strategies of adolescent vaccination programs in selected Italian regions.

Region	MenB Offered to Adolescents*	HPV Offered to Adolescents*	Type of immunization registry (*diversity in the software systems and data flows in place*)	Notable
Sicily	11-18 years of age for naïve subjects (2 dose schedule) and 15-18 years for subjects previously vaccinated with 2 or 3 doses during childhood (2 dose schedule)	11-14 years of age (2 dose-schedule) and, from 15 years of age (3 dose-schedule) free of charge for cohorts born from 1996 onwards for females and from 2003 onwards for males, where not yet vaccinated. Offered as a co-payment for female birth cohorts <1996 and male birth cohorts <2003	Full computerised, different software, individual data real-quarterly	Low uptake, socio-economic barriers [39]
Puglia [55]	11-12 years of age, co-administration with tetravalent MenACYW vaccination	Girls and boys of 11-17 years of age (2-dose schedule for 11-14 years old, 3-dose schedule for subjects 14-18 years)	Full computerised, same software, individual data real-time	NA
Basilicata [56]	From 11 years of age	Girls and boys of 11-17 years of age (2-dose schedule for 11-14 years old, 3-dose schedule for subjects 14-18 years). Offered to 24-year-old women not previously vaccinated, on their first cervical screening appointment	Full computerised, same software, individual data real-time	NA
Calabria [57]	11-17 years of age (2 dose schedule)	Girls and boys of 11-17 years of age (2 or 3 dose schedule depending of age). Offered to 25-year-old women not previously vaccinated	Partially computerised, same software, aggregate data annually	
Liguria	11-17 years of age. Active call for 13-14-years-old subjects not previously vaccinated, co-administered with MenACWY. A booster is also recommended for not naïve adolescents who received vaccination at 2-10 years of age (same vaccine used for the primary series)	Girls and boys 11-19 years of age (2-dose schedule). Offered to women until the start of cervical screening (dose schedule according to SmPC vaccines in use)	Full computerised, different software, individual data annually	Pharmacy-based HPV campaigns [27].
Molise [58]	Active offer to 13 years of age (starting with 2011 birth cohort). Offered to 17 years of age (2007 birth cohort) if parents requested and regardless of vaccination status	Girls and boys of 11-17 years of age (2-dose schedule for 11-14 years old, 3-dose schedule for subjects after 15 years). Catch-up call for subjects up to 25 years	Full computerised, same software, aggregate data annually	NA

* Indicated as full years of age. NA: not available.
This table summarizes MenB vaccine inclusion, HPV offer, registry infrastructure, delivery models, and strategic innovations across key regions. Vaccine indications for special populations are not included [2, 10, 24, 28, 33-41, 44, 48-60].

structured campaign combining screening, outreach, and broad agecohort targeting, extending immunization beyond traditional pediatric ages. A successful HPV extension model to adult cohorts through integration with screening programs and seamless referral from gynecological services achieved 86% adherence [38].

Piemonte is another region that adopted early and proactive strategies, including extension of vaccination offers to broader age cohorts, offering the vaccine to all individuals aged 11 and above, and providing facilitated pathways for high-risk populations such as HIV-positive men and women with cervical lesions [39].

By contrast, in southern regions such as Sicily, completion rates remained below 50%, underscoring the need for enhanced outreach, especially among socioeconomically disadvantaged groups [13].

Another key structural issue limiting equity and efficiency is the inconsistent accessibility of vaccination registries across regions (Tab. III). Vaccination registries integrated with a unified vaccination software system allow for real-time monitoring of coverage rates across local health districts (SSTs), identification of underperforming areas, and implementation of targeted recovery strategies. Some regions, such as Lombardia,

with its ARVAX software, enable healthcare providers to verify vaccination status in real time and even extract data from entire cohorts, facilitating targeted interventions and outreach [27]. In contrast, in other regions, pediatricians and general practitioners may either lack access entirely or face bureaucratic hurdles, reducing the ability to track missed vaccinations and plan catch-up campaigns [27].

"Symphony of Health" platform, adopted by Campania Region, is a computerised vaccination registry designed to improve vaccination coverage, prevent epidemics and facilitate collaboration between paediatricians and general practitioners. The system allows healthcare professionals to consult the vaccination status of every citizen in real time, monitor susceptible cohorts and launch booster campaigns for unprotected individuals, exchange of information between paediatricians and general practitioners to promote continuity of care during the transition from childhood to adulthood [40].

Nonetheless, active call systems, which are crucial for achieving high vaccination uptake, are still not uniformly implemented nationwide. Regions like Lazio have established systematic recall systems for HPV and MenB, often in collaboration with primary care physicians, but other regions such as Sicily and parts of Campania still rely on passive models, contributing to persistently low coverage [41]. This patchwork of policies and practices not only undermines national vaccination goals but also exacerbates health inequalities among adolescents across different parts of Italy.

These disparities underscore the need for national alignment, starting through the inclusion of MenB in adolescent PNPV to active monitoring strategies, supported by ISS data and scientific society recommendations. Establishing clear coverage goals and equitable access mechanisms will be essential to ensuring uniform adolescent protection across the country.

Overcoming vaccine fatigue: adolescent engagement and communication

In recent years, the phenomenon of "vaccine fatigue" has gained relevance as a barrier to immunization uptake, particularly in adolescence. This form of hesitancy reflects emotional and cognitive overload toward vaccination messages, reduced risk perception, and increasing disengagement from preventive health behaviours [6].

To address this, the European Centre for Disease Prevention and Control (ECDC) proposed the 5C model, which identifies five psychological drivers of vaccination behaviour: Confidence, Complacency, Constraints, Calculation and Collective responsibility [8]. Applying this framework can help public health professionals tailor strategies that improve vaccine acceptance by addressing adolescents' specific cognitive and emotional dynamics.

An US study assessed how physicians communicate with patients/parents regarding meningococcal vaccinations, aiming to identify barriers to the implementation of a shared clinical decision making (SCDM) between patients/parents and providers. SCDM recommendation of MenB vaccination for adolescents and young adults resulted inconsistently understood and implemented, because implementing SCDM required to physicians more time and discussion with patients, which could pose a barrier to discussing vaccination [42].

The digital environment plays a dual role in shaping attitudes: while it offers opportunities for health communication, it also poses risks due to the spread of misinformation. Social media platforms like TikTok and Instagram are increasingly used by adolescents as sources of health information; although, these platforms often contain misleading or ambiguous content regarding vaccine safety and efficacy [7]. Real-time social media monitoring initiatives, such as the EU-JAV platform coordinated by the National Institute of Health proved the feasibility of tracking online discourse to inform targeted communication campaigns [43]. However, tackling disinformation also requires stronger roles for trusted figures, such as family, healthcare providers, and schools, in guiding adolescents toward informed health choices [2, 25].

Schools represent a key setting for both education and vaccine delivery. Structured campaigns in regions like Puglia (Taranto) have combined in-school education, parental engagement, and open vaccination access, achieving notable improvements in HPV vaccine coverage [28]. Peer-to-peer education in university settings has also proven effective and may be scalable to secondary schools. In Lombardy, on November 2024, HPV vaccine free of charge together with detailed information on cervical cancer prevention programs and vaccination centres were offered to males and females up to 26 during Open Days at local universities, in collaboration with regional Health Protection Agencies (ATS) [44].

Nevertheless, these experiences remain fragmented and call for a nationally coordinated school-based vaccination strategy integrated into health education curricula [2].

In line with a comprehensive and inclusive communication strategy, community initiatives like the "*Carta di Loreto"* and the "*Manifesto for HPV Cancer Elimination"* have emerged to raise awareness and foster collective commitment toward vaccination. These documents bring together institutions, healthcare professionals, and civil society to promote accessible and evidence-based immunization campaigns, especially for HPV [33, 45].

A multi-actor approach is essential. Pediatricians and general practitioners remain pivotal as vaccine counsellors. Adolescents aged 7-14 are primarily followed by family paediatricians, with the transition to general practitioners often occurring after age 14 (SIP39). During this phase, adolescents risk falling into a healthcare gap that may delay vaccinations [4]. Encouraging paediatricians and GPs to proactively verify immunization status, counsel families and report

updates into regional registries can close this gap [12].
Sports medicine professionals are another strategic but poorly engaged resources. Given their regular interaction with healthy adolescents during mandatory medical evaluations for competitive sports, these professionals can verify vaccine status and promote preventive measures, particularly against infections like HPV and meningococcal disease, which have high transmission potential in communal environments [2, 6, 12]. A notable example comes from the collaboration between the Italian Sports Medicine Federation (FMSI) and regional health services, where sports physicians actively engage in health education during medical evaluations. This includes raising awareness about the risks of vaccine-preventable diseases like meningitis and HPV, particularly given the increased risk of transmission in communal environments such as locker rooms and training facilities. Athletes, due to their visibility and public influence, can also serve as powerful advocates for preventive health behaviors and play a vital role in promoting public awareness about vaccination campaigns, particularly among younger and more hesitant populations [46].
Ultimately, fostering adolescent engagement in vaccination requires synergistic efforts from schools, healthcare professionals, families and community institutions. Tailored, age-appropriate communication strategies grounded in behavioural science, such as the 5Cs, should be deployed alongside flexible, accessible vaccine delivery models to overcome vaccine fatigue and enhance coverage.

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Conflicts of interest statement

All authors declare that they have no conflicts of interest.

Author's contributions

All authors contributed equally to this work.

References

[1] Principi N, Esposito S. Adolescents and vaccines in the western world. Vaccine 2013;31:5366-74. https://doi.org/10.1016/j.vaccine.2013.08.092.

[2] Salutequità. Vaccinazioni ed equità: focus su meningococco in età adolescenziale. 11° Report. Available at: https://salutequita.it/wp-content/uploads/2023/02/Report_Salutequita-suvaccinazione_adolescenti_focus-meningococco_final-x-sito.pdf. Accessed on: 30/04/2026.

[3] Pelullo CP, Di Giuseppe G. Vaccinations among Italian adolescents: Knowledge, attitude and behavior. Hum Vaccin Immunother 2018;14:1566-72. https://doi.org/10.1080/21645515.2017.1421877.

[4] Rand CM, Shone LP, Albertin C, Auinger P, Klein JD, Szilagyi PG. National health care visit patterns of adolescents: implications for delivery of new adolescent vaccines. Arch Pediatr Adolesc Med 2007;161:252-9. https://doi.org/10.1001/archpedi.161.3.252.

[5] Lawrence SM, Saab MM, Savage E, Hegarty J, FitzGerald S. Adolescents' perspectives and experiences of accessing general practitioner services: A systematic review. J Child Health Care 2025;29:734-54. https://doi.org/0.1177/13674935241239837

[6] Moreira da Cunha N, Tzirita S, Gobbo E, Herzig van Wees S. Factors influencing adolescents' decision-making about COVID-19 vaccination: a systematic review with qualitative synthesis. Front Public Health 2025;14:13:1563677. https://doi.org/10.3389/fpubh.2025.1563677.

[7] Parisi L, Mulargia S, Comunello F. Bernardini V, Bussoletti A, Nisi CR, Russo L, Campagna I, Lanfranchi B, Croci I, Grassucci E, Gesualdo F. Exploring the vaccine conversation on TikTok in Italy: beyond classic vaccine stances. BMC Public Health 2023;23:880. https://doi.org/10.1186/s12889-023-15748-y.

[8] ECDC OPERATIONAL SUPPORT. Tools and methods for promoting vaccination acceptance and uptake: a social and behavioural science approach. April 2025. Available at: https://www.ecdc.europa.eu/sites/default/files/documents/vaccination-acceptance-uptake-tools-social-behavioural-science.pdf. Accessed on: 30/04/2026.

[9] Epicentro ISS. PNPV 2023-2025. Available at: https://www.epicentro.iss.it/vaccini/piano-nazionale-vaccini-2023-2025. Accessed on: 30/04/2026.

[10] Calendario per la Vita 2025. 5° edizione. Available at: https://www.fimp.pro/images/aree%20tematiche/Calendario_Vaccinale_per_la_Vita_2025_241218_131601.pdf. Accessed on: 30/04/2026.

[11] Paduano G, Di Giuseppe G, D'Antonio G, Ilardi M, Nese G, Pavia M. Adherence and Willingness to Participate in Cancer Screening Programs Among Women Living in Prison: A Cross-Sectional Study in Southern Italy. Healthcare (Basel) 2025;13:2735. https://doi.org/10.3390/healthcare13212735.

[12] Boccalini S, Zanella B, Landa P, Amicizia D, Bechini A, Innocenti M, Iovine M, Lecini E, Marchini F, Paolini D, Sartor G, Zangrillo F, Lai PL, Bonanni P, Panatto D. Why the Anti-Meningococcal B Vaccination during Adolescence Should Be Implemented in Italy: An Overview of Available Evidence. Microorganisms 2020;8:1681. https://doi.org/10.3390/microorganisms8111681.

[13] Torrisi M, Casigliani V, Mammolenti E, Porretta A, Rizzo C, Tavoschi L. Inequalities in HPV vaccine offer among Italian regions: Analysis of regional prevention plans. Hum Vaccin Immunother 2025;21:2546196. https://doi.org/10.1080/21645515.2025.2546196.

[14] Nikitas G, Comparoni S, Nugnes M, Saragoni S, Castagna S, Marijam A. SA58 Meningococcal Serogroup B Vaccination Coverage of Infants, Children, & Adolescents in Different Regions in Italy: A Retrospective Administrative Database Study. Value in Health 2024;27:S625. https://doi.org/10.1016/j.jval.2024.10.3139.

[15] Reyna VF, Farley F. Risk and Rationality in Adolescent Decision Making: Implications for Theory, Practice, and Public Policy. Psychol Sci Public Interest 2006;7:1-44. https://doi.org/10.1111/j.1529-1006.2006.00026.x.

[16] SIPPS. Adolescenza e transizione dal pediatra al medico dell'adulto. Guida pratica intersocietaria. https://www.sipps.it/pdf/editoriale/SIP39_guidaTRANSIZIONE_A5_MINsal_231017.pdf. Accessed on: 30/04/2026.

[17] Guedes S, Bricout H, Langevin E, Tong S, Bertrand-Gerentes I. Epidemiology of invasive meningococcal disease and sequelae in the United Kingdom during the period 2008 to 2017 - a sec-

ondary database analysis. BMC Public Health. 2022;22(1):521. https://doi.org/10.1186/s12889-022-12933-3.

[18] Bosis S, Mayer A, Esposito S. Meningococcal disease in childhood: epidemiology, clinical features and prevention. J Prev Med Hyg 2015;56:E121-4. PMCID: PMC4755120.

[19] Giufré M, Camilli R, Neri A, Del Manso M, Fazio C, Urciuoli R, Boros S, Giancristofaro S, Vacca P, Del Grosso M, Maraglino F, Siddu A, Ferrao C, Palamara AT, Pezzotti P, D'Ancona FP, Stefanelli P. Sorveglianza nazionale delle malattie batteriche invasive. Dati 2022-2024. Roma: Istituto Superiore di Sanità; 2025 (Rapporti ISS Sorveglianza RIS-2/2025) https://www.epicentro.iss.it/meningite/pdf/RIS-2_2025.pdf. Accessed on: 30/04/2026.

[20] World of Health Organization (WHO). Meningitis. April 1, 2025. https://www.who.int/news-room/fact-sheets/detail/meningitis. Accessed on: 04/05/2026.

[21] Baba SK, Alblooshi SSE, Yaqoob R, Behl S, Al Saleem M, Rakha EA, Malik F, Singh M, Macha MA, Akhtar MK, Houry WA, Bhat AA, Al Menhali A, Zheng ZM, Mirza S. Human papilloma virus (HPV) mediated cancers: an insightful update. J Transl Med 2025;23:483. https://doi.org/10.1186/s12967-025-06470-x.

[22] Haręża DA, Wilczyński JR, Paradowska E. Human Papillomaviruses as Infectious Agents in Gynecological Cancers. Oncogenic Properties of Viral Proteins. Int J Mol Sci 2022;23:1818. https://doi.org/10.3390/ijms23031818.

[23] Wilailak S, Kengsakul M, Kehoe S. Strategic approaches for global cervical cancer elimination: An update review and call for national action. Int J Gynaecol Obstet 2025;171 Suppl 1(Suppl 1):120-8. https://doi.org/10.1002/ijgo.70276.

[24] Bogani G, Ghelardi A, Sopracordevole F, Annoni M, Ciavattini A, Giannella L, De Vincenzo R, Cattani P, Barbero M, Vercellini P, Raspagliesi F, Bonanni P, Scambia G. Human papillomavirus (HPV) vaccination: a call for action in Italy. Int J Gynecol Cancer 2023;33:1132-9. Bosis S, Mayer A, Esposito S. Meningococcal disease in childhood: epidemiology, clinical features and prevention. J Prev Med Hyg 2015;56:E121-4. https://doi.org/10.1136/ijgc-2023-004275.

[25] Montalti M, Salussolia A, Capodici A, Scognamiglio F, Di Valerio Z, La Fauci G, Soldà G, Fantini MP, Odone A, Costantino C, Leask J, Larson HJ, Lenzi J, Gori D; Other Researchers of the OBVIOUS Board. Human Papillomavirus (HPV) Vaccine Coverage and Confidence in Italy: A Nationwide Cross-Sectional Study, the OBVIOUS Project. Vaccines (Basel) 2024;12:187. https://doi.org/10.3390/vaccines12020187.

[26] Menicagli D, Casigliani V, Tavoschi L, Gandolfi S. Digital Assessment and Intervention based on HPV vaccination hesitancy and related cognitive biases. Popul Med 2023;5(Supplement):A2035. https://doi.org/10.18332/popmed/164707.

[27] Bechini A, Cosma C, Di Pisa G, Fanfani A, Ionita G, Liedl D, Lunetta C, Martorella L, Mele S, Stacchini L, Vaccaro G, Zuccaro O, Valente S, Prandi GM, Bonanni P, Boccalini S. Human Papilloma Virus Vaccination and Cervical Screening in the Italian Regions: An Overview of the Current State of the Art. Vaccines (Basel) 2024;12:504. https://doi.org/10.3390/vaccines12050504.

[28] Signorelli C, Pennisi F, D'Amelio AC, Conversano M, Cinquetti S, Blandi L, Rezza G. Vaccinating in Different Settings: Best Practices from Italian Regions. Vaccines (Basel) 2024;13:16. https://doi.org/10.3390/vaccines13010016.

[29] ISS Epicentro. Measles & Rubella News: data as of December 31, 2025. February 19th, 2026. https://www.epicentro.iss.it/morbillo/aggiornamenti#:~:text=In%20Italia%2C%20dal%201%20gennaio%20al%2031,11%20casi%20probabili%20e%2021%20casi%20possibili. Accessed on: 04/05/2026.

[30] Khatami A, Clutterbuck EA, Thompson AJ, McKenna JA, Pace D, Birks J, Snape MD, Pollard AJ. Evaluation of the induction of immune memory following infant immunisation with serogroup C Neisseria meningitidis conjugate vaccines--exploratory analyses within a randomised controlled trial. PLoS One 2014;9:e101672. https://doi.org/10.1371/journal.pone.0101672.

[31] Rupp R, Rosenthal SL, Middleman AB. Vaccination: an opportunity to enhance early adolescent preventative services. J Adolesc Health 2006;39:461-4. https://doi.org/10.1016/j.jadohealth.2006.04.007.

[32] Boccalini S, Del Riccio M, Crescioli G, Salvati C, Sadotti A, Cacini C, Cerini G, Iamarino JA, Ionita G, Stancanelli E, Albora G, Bonanni P, Vannacci A, Bechini A. Safety of co-administration of injectable vaccines in individuals under 18 years of age: A systematic literature review. Hum Vaccin Immunother 2025;21:2592425. https://doi.org/10.1080/21645515.2025.2592425.

[33] Carta di Loreto. Documento di Advocacy per la Prevenzione dell'HPV nelle Marche. Available at: https://www.vaccinarsinellemarche.org/assets/uploads/files/carta-di-loreto.pdf. Accessed on: 30/04/2026.

[34] Regione Veneto. Calendario Vaccinale per età, Agosto 2023. Available at: https://www.vaccinarsinveneto.org/assets/uploads/files/14/allegato-b-calendarioeta.pdf. Accessed on: 30/04/2026.

[35] Regione Emilia-Romagna. PIANO REGIONALE DELL'EMILIA-ROMAGNA PER LA PREVENZIONE VACCINALE 2023-2025. Available at: https://bur.regione.emilia-romagna.it/bur/area-bollettini/n-362-del-27-12-2023-parte-seconda/approvazione-del-piano-regionale-dellemilia-romagna-per-la-prevenzione-vaccinale-2023-2025/allegato-1-piano-regionale-e-r-2023-12-21-1703146798. Accessed on: 30/04/2026.

[36] Piano Regionale Vaccini Lombardia. Available at: https://www.regione.lombardia.it/sanita/wikivaccini/vaccinazioni-per-fascia-di-eta/il-calendario-vaccinale. Accessed on: 30/04/2026.

[37] Piano Regionale Vaccini Liguria. Available at: https://decretidigitali.regione.liguria.it/ArchivioFile/AMM2023916/REG_AMM_A_916_2023.pdf. Accessed on: 30/04/2026.

[38] Ufficio Stampa Provincia Autonoma di Trento. Hpv: in Trentino campagna da 87mila vaccinazioni. Available at: https://www.ufficiostampa.provincia.tn.it/layout/set/print/Comunicati/Hpv-in-Trentino-campagna-da-87mila-vaccinazioni 1/. Accessed on: 30/04/2026.

[39] Regione Piemonte. Campagna vaccinale contro il Papilloma Virus. Available at: https://www.regione.piemonte.it/web/temi/sanita/campagna-vaccinale-contro-papilloma-virus#. Accessed on: 30/04/2026.

[40] Europacampania.it. Sinfonia Salute, the new Digital Health App of Campania. Available at: https://europa.regione.campania.it/en/sinfonia-salute-la-nuova-app-della-sanita-digitale-della-campania/. Accessed on: 30/04/2026.

[41] Riccò M, Cerviere MP, Marchesi F, Bottazzoli M. Invasive Meningococcal Disease and Meningococcal Serogroup B Vaccination in Adults and Their Offspring: Knowledge, Attitudes, and Practices in Italy (2019). Vaccines (Basel) 2023;11:508. https://doi.org/10.3390/vaccines11030508.

[42] Herrera-Restrepo O, Bunniran S, Mond T, et al. Physician Communication with Patients/Parents on MenB Vaccination for Older Adolescents and Young Adults. J Adolesc Health 2024;72:S90. https://doi.org/10.1016/j.jadohealth.2023.11.394.

[43] Rizzo C, Gesualdo F, Lanfranchi B, Armeni R, Rota MC, Filia A. Una piattaforma europea per il monitoraggio delle conversazioni sui vaccini su web e social network. Boll Epidemiol Naz 2021;2(2):7-15. https://www.iss.it/documents/20126/0/Una+piattaforma+europea+per+il+monitoraggio+delle+conversazioni+sui+vaccini+su+web+e+social+network.pdf/18e906aa-85bb-dd8a-a2df-e542ee2d7817?t=1741001025030. Accessed on: April 30, 2026.

[44] Regione Lombardia. Sanità, open day vaccinali nelle università lombarde per prevenire il tumore della cervice uterina. 15 Novembre 2024. Available at: https://www.lombardianotizie.

online/comunicato-stampa/lnews-sanita-open-day-vaccinali-nelle-universita-lombarde-per-prevenire-il-tumore-della-cervice-uterina/. Accessed on: 30/04/2026.

[45] Baker, P (2024). Making a Difference: Advocating for HPV Policy Change. A Practical Guide. European Cancer Organisation; Brussels. Available at: https://www.europeancancer.org/resources/publications/reports/advocating-hpv-policy-change.html. Accessed on: 30/04/2026.

[46] Gabellone V, Nuccetelli F, Fortunato F, Ascatigno L, Prato R, Lopalco PL. Opinions and attitudes toward influenza vaccination among male Italian volleyball Serie A athletes in the 2024/25 season. J Sci Med Sport 2025;10:S1440-2440(25)00485-2. https://doi.org/10.1016/j.jsams.2025.11.002.

[47] Ministero della Salute. Vaccinazioni dell'adolescente. Anno 2024 (coorte 2008 - 16 anni) Coperture vaccinali (per 100 abitanti) per vaccinazioni dell'adolescente, calcolate sui riepiloghi inviati dalle Regioni e PP.AA. (per singolo antigene). Available at https://www.salute.gov.it/new/sites/default/files/2025-12/Allegato%202_Tabelle%20CV-6.pdf. Accessed on: 30/04/2026.

[48] D'Ancona F, Gianfredi V, Riccardo F, Iannazzo S. Immunisation Registries at regional level in Italy and the roadmap for a future Italian National Registry. Ann Ig 2018;30:77-85. https://doi.org/10.7416/ai.2018.2199.

[49] Piano Regionale Vaccini Trento. Available at: https://www.vaccinarsintrentino.org/assets/uploads/files/321/delibera-della-giunta-provinciale-della-provincia-autonoma-di-trento-n.-1173-dell-8-agosto-2025.pdf. Accessed on: 30/04/2026.

[50] Regione Marche. Norme Marche. Adeguamento dell'offerta vaccinale nelle Marche in relazione al recepimento del nuovo Piano Nazionale Prevenzione Vaccinale 2023-2025 – Approvazione del Calendario Vaccinale Regionale e direttive alle Aziende del SSR. Allegato B. Available at: https://www.vaccinarsinellemarche.org/assets/uploads/files/8/1.2-dgr-piano-vaccini-prot.pdf. Accessed on: 30/04/2026.

[51] Regione Lazio. Calendario Vaccinale. Available at: https://www.vaccinarsinlazio.org/assets/uploads/files/9/regione-lazio-calendario-vaccinale.pdf. Accessed on: 30/04/2026.

[52] AIOP Campania. Ulteriori misure per la prevenzione della malattia meningococcica nella fascia di età. DECRETO N. 28 DEL 25.03.2019. adolescenziale. Available at: https://www.aiopcampania.it/public/normativa/4b06bd76312d445d85b9f8caa6082a8b.pdf. Accessed on: 30/04/2026.

[53] Calendario Vaccinale Sicilia 2024. Available at: https://www.vaccinarsinsicilia.org/assets/uploads/files/9/2024-calendario-vaccinale-per-la-vita-della-regione-sicilia.pdf. Accessed on: 30/04/2026.

[54] Guarducci G, Chiti M, Fattore DC, Caldararo R, Messina G, Filidei P, Nante N. Development of a network model to implement the HPV vaccination coverage. Ann Ig 2024;36:636-43. https://doi.org/10.7416/ai.2024.2630.

[55] Regione Toscana. Calendario vaccinale della Regione Toscana e direttive in materia di vaccinazioni. Aggiornamento 2026. Available at: https://www301.regione.toscana.it/bancadati/atti/Contenuto.xml?id=5510125&nomeFile=Decreto_n.7908_del_15-04-2026-Allegato-A. Accessed on: 30/04/2026.

[56] Giampà V, Paduano S, Frasca G, Mattei G, Diegoli G, Bargellini A, Cintori C. Human Papillomavirus (HPV) vaccination recovery campaign in Emilia-Romagna region, Italy: impact on vaccination coverage in women up to 25 years. Popul Med 2023;5(Supplement):A2000. https://doi.org/https://doi.org/10.18332/popmed/165637.

[57] Sistema Informativo Sanitario Territoriale Puglia. Bollettino Ufficiale della Regione Puglia - n. 135 del 29-10-2021. Available at: https://sist.sanita.puglia.it/documents/20182/285275922/DGR+1589_2021+Nuovo+calendario+vaccinale+ed.2021.pdf/186500a3-134e-4dae-9d5c-c6e139280bcd. Accessed on: 30/04/2026.

[58] Regione Basilicata. Calendario vaccinale per la vita 2021. Available at: https://www.farmindustria.it/app/uploads/2021/11/DGR-890_2021-calendario-vaccinale-per-la-vita-2021.pdf. Accessed on: 30/04/2026.

[59] Regione Calabria. Calendario Vaccinale. Available at: https://burc.regione.calabria.it/ricerca.jsp?q=YW5ubz0yMDIyIyMjbnVtZXJvPSMjI2RhdGFCVVJDQWw9IyMjZGF0YUJVUkNEYWw9MTUvMDQvMjAyMiMjI2RhdGFBdHRvPSMjI251bWVyb0F0dG89IyMjb2dnZXR0bz12YWNjaW5hbGUjIyNpZFNlemlvbmU9. Accessed on: 30/04/2026.

[60] Regione Molise. Calendario per la vita 2024. Available at: https://www.regione.molise.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/20075. Accessed on: 30/04/2026.

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HEALTH PROMOTION

Exploring Health Literacy Levels and Influencing Factors of Indonesian Migrant Workers in Hong Kong

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Keywords

Indonesian Migrant Workers • Health Literacy • Hong Kong • Health Interventions • Migrant Health • Health Equity

Summary

Introduction. *Immigration is increasingly recognized as a social determinant of health, shaping migrants' access to health information, preventive services, and appropriate care. For Indonesian Migrant Workers (IMWs) in Hong Kong, structural barriers including precarious employment conditions, language barriers, and limited social protection may constrain health literacy and health-seeking behavior. This study aimed to assess the health literacy levels of IMWs in Hong Kong and identify the sociodemographic and occupational factors associated with their health literacy.*

Methods. *A cross-sectional study was conducted with 62 IMWs in Hong Kong. Data were collected using the Health Literacy Survey Short Form (HLS-SF12) and analyzed using descriptive statistics and multiple linear regression with JASP software.*

Results. *The mean health literacy score was 33.9 (SD=6.45), with most respondents classified as having sufficient health literacy (72.6%), followed by excellent (19.4%) and problematic (8.1%), and none categorized as inadequate. The overall regression model was not statistically significant (F(13, 47)=1.742, p=0.083); however, occupation was the only significant predictor, with elderly homecare workers scoring significantly higher than domestic workers (B=7.064, p=0.018).*

Conclusion. *These findings suggest that health literacy among IMWs in Hong Kong is more strongly shaped by occupational context and structural determinants than by individual sociodemographic characteristics. Targeted, occupation-specific interventions and broader structural reforms, including language-accessible health resources and integration of health literacy into pre-departure training, are essential to reduce health inequities among IMWs in Hong Kong.*

Introduction

In the ever-evolving era of globalization, international migration has become an increasingly important public health issue. Compared with the past, international migration now has a broader impact on countries, communities, and everyday life [1]. As the number of migrants and refugees continues to rise, healthcare systems in host countries are required to respond to diverse and growing health needs [2]. However, migration is not only a matter of population movement or healthcare access. It is also closely related to social, economic, legal, occupational, and structural conditions that shape health risks, health behaviors, and health outcomes.

Immigration is increasingly recognized as a social determinant of health. A social determinants of health perspective emphasizes that health is shaped not only by individual behavior or medical care, but also by broader social and structural conditions, including employment, housing, legal status, language access, social protection, discrimination, and healthcare systems. In this sense, migration status can influence health by determining whether migrants are able to access reliable health information, preventive services, safe working and living conditions, and appropriate healthcare. Castañeda et al. [3] argue that immigration should be understood not merely as a background characteristic, but as a social determinant in its own right because it affects migrants' relationships with institutions, resources, rights, and everyday security. Similarly, Wickramage et al. [4] emphasize that migration and health research should adopt a social determinants approach and consider how different phases of migration shape health vulnerability and resilience.

This conceptual framing is particularly relevant for migrant workers, many of whom work in precarious and gendered employment sectors. Labour migration can bring economic benefits to both countries of origin and destination, yet these benefits are strongly dependent on safe, orderly, and humane migration practices. Migrant workers may experience limited access to health services, restrictive employment conditions, language barriers, social isolation, and limited protection within host societies [5-7]. These conditions can affect not only physical and mental health, but also health literacy, because the ability to access, understand, appraise, and use health information is shaped by the social and institutional environments in which migrants live and work.

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For years, Hong Kong has been a major destination for Indonesian migrant workers. Hong Kong is among the top destinations for Indonesian migrant workers, and Indonesian women constitute a large proportion of migrant domestic workers in the city [8]. Indonesian Migrant Workers (IMWs) or PMI (*Pekerja Migran Indonesia*) refers to any Indonesian citizen who will, is, or has worked for wages outside the territory of the Republic of Indonesia [9]. Placement data show that the number of Indonesian migrant workers remains substantial, with many working in informal sectors. From 2019 to 2021, the placement of Indonesian migrant workers in Hong Kong remained high, with 71,779 workers in 2019, 53,178 in 2020, and 52,278 in 2021 [8]. These figures indicate the continuing importance of Hong Kong as a destination for Indonesian migrant workers and highlight the need to understand their health needs in the host-country context.

Migrant domestic workers are a particularly important group within this context. A recent scoping review of migrant domestic worker health and well-being in the Western Pacific Region reported that Hong Kong hosted 339,451 migrant domestic workers in 2021, including 140,057 workers from Indonesia. The same review identified several key social determinants affecting migrant domestic worker health, including living and working conditions, personal and financial resources, health knowledge and behaviors, community resources, stigma and discrimination, healthcare access, exploitation within the migration employment industry, and governance [5]. These findings suggest that the health of Indonesian migrant workers in Hong Kong cannot be understood only through individual-level factors. Instead, their health and health literacy are embedded within broader structural and occupational conditions.

Migrants must be included in prevention and control strategies at global, national, and local levels to support the Sustainable Development Goals for Universal Health Coverage, the Global Compact for Safe, Orderly, and Regular Migration, and World Health Assembly Resolution 70.15 on promoting migrant health [1]. Despite growing attention to the relationship between population mobility and migrant health, access to reliable health information remains a major challenge, especially when language, political, social, and employment-related barriers are involved [10]. For Indonesian migrant workers in Hong Kong, these barriers may affect their ability to seek healthcare, understand health risks, follow preventive recommendations, and make informed health decisions.

The concept of health literacy is increasingly important in public health. Health literacy encompasses the ability to access, understand, appraise, and use health information for disease prevention, health promotion, and quality of life improvement. Sørensen et al. [11], define health literacy as the ability to comprehend health-related information and use it to make decisions concerning healthcare, disease prevention, and health promotion. Health literacy also enables individuals to manage their health-related actions across social, personal, and environmental domains and supports more effective use of healthcare services [12]. In other words, health literacy is closely associated with health promotion and prevention, and it has become increasingly important in contemporary society [13].

Low health literacy can have detrimental effects on public health. It has been associated with higher mortality, increased hospitalization, lower use of preventive health services, poor adherence to prescribed medications, difficulty communicating with healthcare professionals, and poorer knowledge of disease processes and self-management among people with chronic conditions such as diabetes, heart disease, and arthritis [14-19]. Low health literacy is also associated with higher healthcare costs, increased inpatient and emergency department use, and poorer health outcomes [20, 21]. For Indonesian migrant workers in Hong Kong, improving health literacy is crucial because they constitute a large migrant population with diverse employment roles, significant contributions to the labor force, and potential exposure to structural health inequities.

Existing evidence from Hong Kong further shows that health literacy among migrant domestic workers is closely related to health information behavior. Oktavianus et al. [22] examined Indonesian migrant domestic workers in Hong Kong during the COVID-19 pandemic and found that workers acquired, verified, shared, and acted upon health information through social networks, family members, community organizations, media outlets, and digital platforms. The study also showed that limited access to credible information in workers' native language, exposure to misinformation, and dependence on informal information sources could affect preventive behavior. These findings suggest that health literacy among Indonesian migrant workers in Hong Kong is not only an individual skill, but also a socially situated process shaped by language access, digital information environments, community networks, and trust in information sources.

Despite growing research on health literacy among migrants globally, specific evidence on Indonesian migrant workers in Hong Kong remains limited. Studies from developed countries, including Germany and Australia, have shown that ethnic minorities and migrants are at higher risk of low health literacy [23, 24]. However, these findings may not be directly transferable to the socio-cultural, occupational, and migration contexts of Indonesian migrant workers in Hong Kong. Studies by Cheong et al. [25] and Kosiyaporn et al. [26] further underscore the importance of cultural, linguistic, and socioeconomic factors in shaping health literacy among migrant workers. However, these studies have focused primarily on other migrant populations, such as Filipino domestic workers in Macao or general migrant health workers in Thailand, with limited emphasis on Indonesian migrant workers in Hong Kong.

Moreover, systemic barriers such as discrimination, inadequate health insurance, precarious work arrangements, and limited access to health-protective

resources may contribute to health inequalities among migrant workers. Evidence from Indonesian workers in other host countries, such as South Korea, points to structural inequalities that may also be relevant in Hong Kong [27, 28]. However, detailed studies addressing how employment role, educational background, length of employment, and migration-related social conditions shape the health literacy of Indonesian migrant workers in Hong Kong remain scarce. This gap underscores the need for context-specific research that positions migrant health literacy within the broader framework of immigration as a social determinant of health.

To address this gap, the objectives of this study are twofold: (1) to evaluate the health literacy levels of Indonesian migrant workers in Hong Kong and (2) to identify the key factors influencing their health literacy. By focusing on this specific socio-cultural, occupational, and migration context, this study aims to provide a deeper understanding of Indonesian migrant workers as a critical yet understudied migrant population. Identifying determinants such as employment role, educational background, and length of employment may help inform targeted interventions to improve health literacy, reduce health inequities, and support better health outcomes among Indonesian migrant workers in Hong Kong.

Methods

Study Design and Setting

This study employed a quantitative method using a cross-sectional survey approach. The study aimed to measure the health literacy levels of Indonesian Migrant Workers (IMWs) in Hong Kong and to identify factors associated with their health literacy. Data were collected in late January 2024 during activities held at the Indonesian Consulate in Hong Kong. Data were collected in late January 2024 during community activities held at the Indonesian Consulate in Hong Kong. This setting was selected because consulate-based activities provided access to IMWs who may otherwise be difficult to reach due to their work schedules, mobility constraints, and employment arrangements.

Participants and recruitment

The target population comprised IMWs residing and working in Hong Kong. Participants were recruited using convenience sampling during activities at the Indonesian Consulate in Hong Kong. This sampling method was considered appropriate because IMWs represent a relatively hard-to-reach population, and recruitment was limited to participants who were accessible during the data collection period and willing to complete the questionnaire voluntarily.

A total of 62 respondents were included in the final analysis. The sample size was determined based on the number of eligible participants who completed the questionnaire during the study period. Although the sample size was relatively small, it was considered acceptable for an exploratory cross-sectional study involving a migrant worker population with practical recruitment constraints. However, due to the limited sample size, the findings should be interpreted cautiously, particularly for multivariable analysis. The small sample size was also acknowledged as a limitation of the study. A priori power calculation was not conducted before data collection because the study was exploratory and recruitment depended on participant availability during consulate-based activities. Nevertheless, the final sample size was considered sufficient to provide preliminary evidence regarding the distribution of health literacy and its potential associated factors among Indonesian migrant workers in Hong Kong.

Eligibility criteria

Participants were included if they met the following criteria: they were Indonesian migrant workers currently residing and working in Hong Kong, aged 18 years or older, able to understand Indonesian, and willing to participate in the study. Respondents were excluded if they did not provide informed consent, did not complete the questionnaire, or submitted incomplete responses for the main study variables required for analysis.

Data collection procedures

Data were collected using a structured self-administered questionnaire distributed through Google Forms. Before completing the questionnaire, participants were provided with information about the purpose of the study, the voluntary nature of participation, confidentiality of responses, and their right to withdraw from the study at any time. Participants who agreed to take part proceeded to complete the questionnaire.

Variables and Instruments

Sociodemographic Variables

Sociodemographic and employment-related data collected in this study included sex, marital status, number of children, educational background, occupation, insurance ownership, monthly income, and length of employment. These variables were used to describe the characteristics of the respondents and to examine their potential association with health literacy levels. Occupational categories included domestic worker, elderly homecare worker, babysitter or child caregiver, and private employee. Length of employment was recorded in months as a continuous variable.

Health Literacy

Health literacy was measured using the 12-item short-form Health Literacy Survey Questionnaire (HLS-SF12) developed by Duong et al. [29] which was derived from the 47-item European Health Literacy Survey Questionnaire (HLS-EU-Q47) developed by Sørensen et al. [30]. The HLS-SF12 has been validated in the general population across six Asian countries and assesses individuals' perceived ability to access, understand, appraise, and apply health-related information.

The questionnaire was administered in Indonesian, the participants' native language. Respondents were asked

to rate the perceived difficulty of each health-related task using a four-point Likert scale: very difficult, difficult, easy, and very easy. Higher scores indicated better perceived health literacy. The health literacy index was standardized to a unified metric ranging from 0 to 50 using the following formula:

$$Index = (mean - 1) \times \left(\frac{50}{3}\right)$$

In this formula, the index represents the calculated health literacy score, while the mean refers to the average score of all completed items for each respondent. The value 1 represents the minimum possible value of the mean, 3 represents the range of the mean, and 50 represents the maximum value of the standardized metric. Therefore, an index score of 0 indicates the lowest level of health literacy, while a score of 50 indicates the highest level of health literacy.

Statistical Analysis

Data were analyzed using descriptive and inferential statistics. Descriptive statistics were used to summarize respondents' sociodemographic and employment-related characteristics. Categorical variables, including sex, marital status, number of children, educational background, insurance ownership, occupation, and income, were presented as frequencies and percentages. Length of employment was treated as a continuous variable and presented as mean and standard deviation.

Multiple linear regression analysis was performed to identify factors associated with the health literacy index among IMWs. The health literacy index score was treated as the dependent variable. The independent variables included sex, marital status, number of children, educational background, insurance ownership, monthly income, occupation, and length of employment. Categorical variables with more than two categories were dummy-coded prior to analysis. Results were reported as unstandardized regression coefficients (B), standard errors (SE), 95% confidence intervals (CI), and p-values. A p-value of less than 0.05 was considered statistically significant. All statistical analyses were performed using JASP (version 0.97)

Ethical Approval

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Indonesia, under approval number 168/EC-KEPK FKIK UMY/IV/2024. All participants received information about the study before participation and provided informed consent electronically before completing the questionnaire. Participation was voluntary, and respondents could withdraw at any stage before submitting their responses. Confidentiality and anonymity were maintained throughout the study.

Results

Sociodemographic of Indonesian Migrant Workers (IMWs) in Hong Kong

A total of 62 IMWs participated in this study. The sociodemographic and employment-related characteristics of the respondents are presented in Table I. Overall, most respondents were female, married, had one child, and had completed either junior or senior high school. Insurance ownership was evenly distributed among respondents. Most respondents worked as domestic workers, followed by babysitters or child caregivers, elderly homecare workers, and private employees. The majority of respondents reported a monthly income of IDR 5-10 million.

Health Literacy Levels of Indonesian Migrant Workers (IMWs) in Hong Kong

The health literacy levels of IMWs are presented in Table II. The mean health literacy index score was

Tab. I. Sociodemographic Status of Indonesian Migrant Workers in Hong Kong.

Variable	Frequency (%)
Length of Employment (in month)	
Mean±SD	104.8±73.89
Sex	
Female	61 (98)
Male	1 (2)
Marital Status	
Single	11 (18)
Married	51 (82)
Number of Children	
No children	12 (19.4)
One child	39 (62.9)
Two or more children	11 (17.7)
Educational Background	
Primary School	6 (10)
Junior High School	26 (42)
Senior High School	26 (42)
Bachelor	4 (8)
Insurance Ownership	
Yes	31 (50)
No	31 (50)
Occupation	
Domestic Worker (DW)	47 (76)
Elderly Homecare (EH)	6 (10
Babysitter (BS)	8 (13)
Private Employee (PE)	1 (2)
Income (in Indonesia Rupiah)	
≤IDR 5 million	7 (11.3)
IDR 5-10 million	54 (87.1)
IDR 10-20 million	1 (1.6)
Total	**62 (100)**

Tab. II. Health Literacy Scores of IWMs in Hong Kong.

HL Index Category	Frequency (%)	Mean±SD
Inadequate	0 (0)	0±0
Problematic	5 (8)	21.94±3.01
Sufficient	45 (72.6)	32.47±2.49
Excellent	12 (19.4)	44.44±2.78
Total	**62 (100.0)**	**33.9±6.45**

33.9±6.45. Most respondents were categorized as having sufficient health literacy, followed by excellent and problematic health literacy. No respondent was categorized as having inadequate health literacy.

Factors Influencing the Health Literacy Index of Indonesian Migrant Workers (IWM)

Linear regression analysis was conducted to examine factors associated with the health literacy index among IMWs. The independent variables included in the model were insurance ownership, length of employment, marital status, number of children, educational background, income, and occupation. The overall linear regression model did not reach statistical significance, $F(13, 47)=1.742$, $p=0.083$. However, in the coefficient analysis, elderly homecare workers had significantly higher health literacy index scores than domestic workers as the reference category (B=7.064, SE=2.880, 95% CI: 1.270 to 12.86, t=2.453, $p=0.018$). Other occupational categories were not significantly associated with the health literacy index. Babysitters or child caregivers did not differ significantly from domestic workers (B=-0.140, SE=2.747, 95% CI: -5.666 to 5.385, t=-0.051, $p=0.959$). Private employees also did not differ significantly from domestic workers (B=10.19, SE=6.494, 95% CI: -2.879 to 23.25, t=1.568, $p=0.123$). Other variables, including insurance ownership, length of employment, marital status, number of children, educational background, and income, were not significantly associated with the health literacy index (Tab. III).

Discussion

Health literacy is a vital component in maintaining health and preventing disease, particularly for Indonesian Migrant Workers (IMWs). These findings may suggest that IMWs in Hong Kong demonstrate a generally adequate level of health literacy, with most respondents classified as having sufficient health literacy. This is broadly consistent with Milanti et al. [31], who found that migrant domestic workers (MDWs) in Hong Kong exhibited good levels of eHealth literacy during the COVID-19 pandemic, partly attributed to their engagement with social media for health information. These observations are also meaningful in light of broader evidence linking health literacy to health outcomes. Mo et al. [32] found that inadequate health literacy was associated with worse mental health outcomes among vulnerable populations, including higher rates of depression and anxiety. While the present study did not measure health outcomes directly, the relatively sufficient health literacy levels observed among IMWs may warrant further investigation into whether these levels are associated with better health-seeking behaviors and well-being in this population. However, these observations should be interpreted cautiously given the small sample size and cross-sectional design of the present study, which substantially constrain the strength of conclusions that can be drawn. One possible explanation for the relatively favorable health literacy levels observed is that IMWs in Hong Kong may benefit from a comparatively supportive peer and community environment relative to migrant workers in other host

Tab. III. Factors Influencing the Health Literacy of IWM .

Variable	B	SE	95% CI	t	*p-value*
Intercept	33.62	3.711	26.15 to 41.08	9.059	<0.001
Insurance ownership: yes	0.141	1.754	-3.388 to 3.670	0.080	0.936
Length of employment	0.017	0.013	-0.009 to 0.043	1.304	0.199
Marital status: not married	2.838	2.490	-2.171 to 7.847	1.140	0.260
Number of children: one child	-1.129	2.556	-6.271 to 4.014	-0.441	0.661
Number of children: two or more children	2.448	2.855	-3.296 to 8.192	0.857	0.396
Educational background: junior high school	3.576	3.101	-2.662 to 9.814	1.153	0.255
Educational background: senior high school	-0.024	3.065	-6.190 to 6.141	-0.008	0.994
Educational background: bachelor's degree	5.230	4.052	-2.921 to 13.38	1.291	0.203
Income: IDR 5–10 million	-5.019	2.980	-11.01 to 0.976	-1.684	0.099
Income: IDR 10–20 million	-7.177	7.170	-21.60 to 7.247	-1.001	0.322
Occupation: babysitter/child caregiver	-0.140	2.747	-5.666 to 5.385	-0.051	0.959
Occupation: elderly homecare worker	**7.064**	**2.880**	**1.270 to 12.86**	**2.453**	**0.018**
Occupation: private employee	10.19	6.494	-2.879 to 23.25	1.568	0.123

B: unstandardized regression coefficient; SE: standard error; CI: confidence interval. The reference categories were no insurance ownership, married, no children, primary school education, income ≤IDR 5 million, and domestic worker. The dependent variable was the health literacy index.

countries, though this interpretation remains speculative and warrants verification in larger, more representative samples.

Rather than reflecting individual capability alone, it is likely that the health literacy patterns observed here are shaped by structural and social factors particular to the Hong Kong context. IMWs heavily rely on close-knit ethnic community networks for both emotional and informational support [33]. It is plausible that these networks facilitate the sharing of health information, particularly through digital platforms such as WhatsApp and Facebook groups. Anggaunitakiranantika [33] highlights how these workers utilize community groups to access a range of resources, including health information, emphasizing the centrality of community in navigating the challenges of living and working in a foreign country. Ethnic media and community organizations further strengthen this support by disseminating vital health information, and during crises such as pandemics, Bernadas et al [34] note that these organizations act as critical intermediaries, ensuring migrant workers receive accurate and timely information from government and health authorities. Critically, however, Oktavianus et al. [22] found that while MDWs in Hong Kong actively sought health information through social networks during the COVID-19 pandemic, this behavior produced both adaptive and maladaptive outcomes, the latter including reliance on unverified content and culturally rooted misconceptions. Ho and Smith [35] similarly cautioned that foreign domestic workers' reliance on informal networks during disease outbreaks may reinforce health misinformation if not supplemented by credible, culturally sensitive institutional communication. This important nuance suggests that community-mediated health information does not automatically translate into improved health literacy, and the quality and accuracy of peer-shared content warrants careful scrutiny in future research.

The widespread use of smartphones among IMWs has transformed how they communicate and access essential resources. Smartphones facilitate not only staying in touch with family but also accessing vital services such as health, education, and banking [36], and may provide a convenient platform for evaluating and utilizing health information. Garner et al. [37] demonstrated that mobile health applications can meaningfully improve health literacy related to hypertension and diabetes among Asian migrant workers in Hong Kong, suggesting that technology-based interventions hold real potential for this population. However, digital access alone does not guarantee meaningful health literacy gains. Zhang et al. [38] demonstrated that health literacy influences health behaviors through multiple pathways, with effects further moderated by gender, suggesting that future studies on IMWs would benefit from adopting multidimensional health literacy instruments capable of distinguishing between functional, communicative, and critical dimensions of health literacy, rather than relying solely on a composite index as in the present study. The capacity to critically appraise health information is further mediated by language proficiency in the host country's language and digital literacy skills, factors not captured in the present study and likely representing important confounders. Jia [39] found that language barriers significantly constrain migrants' access to health information and healthcare services, particularly for those with lower education levels, arguing that language-discordant health systems generate inequalities that are structurally produced rather than individually determined. This points to a broader theoretical concern: consistent with the social determinants of health framework, health literacy among migrant workers cannot be understood purely through the lens of individual attributes, but must be situated within the structural conditions in which workers live and work, including employment arrangements, legal protections, institutional access to healthcare, and the degree of social inclusion afforded in the host society [40, 41]. The largely non-significant associations between individual-level sociodemographic variables and health literacy scores in this study may reflect the overarching influence of these structural determinants, which individual-level instruments are typically ill-equipped to capture.

Occupation emerged as the only statistically significant predictor of health literacy in this study, with elderly homecare workers demonstrating higher scores compared to domestic workers as the reference group. One possible explanation is that homecare roles involve more frequent and direct exposure to healthcare environments, medical terminology, and interactions with health professionals, which may cumulatively enhance workers' capacity to access, understand, and critically evaluate health-related information. This is broadly consistent with prior research linking occupational context to health knowledge across different settings [42–45], and with Güner and Ekmekci [46] who reported better health literacy outcomes among workers in healthcare-adjacent roles. Li et al. [47] further demonstrated that occupational type and employment conditions are among the key factors shaping healthcare utilization among migrant older adults, reinforcing the view that the nature of one's work environment plays a structurally important role in determining health literacy and health-seeking behavior. However, this finding should be interpreted with considerable caution. This may be because the overall regression model was not statistically significant, the elderly homecare subsample was very small (n=6), and the result may be partially confounded by unmeasured variables such as language proficiency, length of stay in Hong Kong, and the degree of autonomy afforded by different occupational roles. Liu et al. [40] demonstrated that among migrants in Hong Kong, socioeconomic disadvantage and limited language proficiency jointly constrain healthcare utilization, factors that likely interact with occupational type in ways this study's sample size could not adequately disentangle. Replication in larger and more diverse samples is therefore necessary before firm conclusions regarding the role of occupation in shaping health literacy among IMWs can be drawn.

The absence of significant associations between

health literacy and variables such as educational background, insurance ownership, income, and length of employment may suggest that, for this population, individual sociodemographic characteristics are less determinative than structural and contextual factors. This finding could partly be explained by the relatively homogeneous sociodemographic profile of the sample, which may have limited the variance needed to detect associations. Notably, the non-significant association between insurance ownership and health literacy may reflect the possibility that formal insurance coverage alone does not guarantee meaningful engagement with health information, particularly when broader structural barriers, such as language-discordant services, limited rest time, and restricted autonomy, remain unaddressed [40,41]. Novrinda and Han [48] similarly found that health insurance alone was insufficient to eliminate health inequalities among Indonesian migrant workers, with discrimination and socioeconomic marginalization remaining significant barriers to equitable health outcomes. From a broader policy perspective, this challenges approaches that focus narrowly on individual-level health education without addressing systemic barriers. Wong et al. [41] proposed a comprehensive health service model for migrants in Hong Kong that integrates culturally sensitive care, language support, and community health engagement, arguing that fragmented, individually focused approaches are insufficient for populations navigating structural disadvantage. Wang et al. [49] further found that social integration, including participation in community activities and engagement with health records, was positively associated with primary healthcare utilization among migrants, suggesting that improving health literacy outcomes may require fostering broader social inclusion rather than delivering standalone educational content. Employment conditions, including long working hours, restricted rest day entitlements, and employer control over daily routines, may substantially limit the time and opportunity IMWs have to engage with health resources, regardless of their underlying literacy capacity. Addressing such multi-layered barriers requires comprehensive, systemic strategies, Mancuso [50] proposed a model for overcoming health literacy barriers that integrates cultural competence, patient-centered communication, and institutional-level reform, emphasizing that sustainable improvements in health literacy cannot be achieved through education alone but require coordinated action across health systems, community organizations, and policymakers. Workers in roles associated with lower health literacy, such as domestic helpers and babysitters, would likely benefit from targeted support informed by this model. Silitonga et al. [51] demonstrated that structured, culturally tailored health education programs can produce meaningful improvements in knowledge among Indonesian women migrant workers, offering a promising evidence base that could be adapted and scaled for health literacy promotion more broadly.

Strengths and Limitations

This study contributes to the limited but growing body of evidence on health literacy among Indonesian migrant workers in Hong Kong, a population that remains underrepresented in health research despite its considerable size and vulnerability. The use of a validated health literacy instrument provides a standardized basis for comparison with other populations and settings, strengthening the interpretability of findings.

However, several limitations must be acknowledged. First, the relatively small sample size (n=62) limits the statistical power of the analysis and reduces the generalizability of findings. The non-significance of the overall regression model may in part reflect insufficient power to detect modest but meaningful associations. Second, recruitment through community networks and convenience sampling may have introduced selection bias, as individuals who were more socially connected and digitally active may have been overrepresented. Consequently, health literacy levels in the broader population of Indonesian migrant workers may differ from those observed in this study. Third, the reliance on self-reported data may be affected by social desirability bias and recall inaccuracies, potentially leading to overestimation of health literacy scores. Fourth, the single geographic setting limits the transferability of the findings to Indonesian migrant workers in other host countries with different healthcare systems, regulatory environments, and levels of community support. Fifth, the cross-sectional design precludes causal inference regarding the relationships between sociodemographic or occupational factors and health literacy outcomes. Longitudinal studies are therefore needed to examine how health literacy develops over time among migrant workers. Finally, several important potential confounders were not assessed, including Cantonese or English language proficiency, length of stay in Hong Kong, degree of social integration, and quality of pre-migration education. As Gao et al. [52] and Jia [39] have shown, these factors may meaningfully influence health outcomes and healthcare access among migrant populations. Therefore, their omission should be considered an important limitation that future research should address.

Conclusion

This study provides preliminary evidence on health literacy among Indonesian migrant workers in Hong Kong and highlights the relevance of occupational context in shaping workers' ability to access, understand, appraise, and apply health information. Most respondents demonstrated sufficient health literacy, and no participants were categorized as having inadequate health literacy. However, the presence of a minority with problematic health literacy indicates that important gaps remain and that the overall findings should not be interpreted as uniformly positive.

Occupation emerged as the only statistically significant

predictor of health literacy, with elderly homecare workers reporting higher scores than domestic workers. This finding suggests that workers whose roles involve greater exposure to caregiving tasks, health-related communication, and interactions with healthcare environments may develop stronger health literacy than those in more general domestic work roles. At the same time, the absence of significant associations with education, income, insurance ownership, and length of employment suggests that health literacy among Indonesian migrant workers may not be determined solely by individual characteristics. Rather, it is likely shaped by broader social and structural factors, including employment conditions, language accessibility, healthcare navigation, and community-based information networks.

These findings have several implications for policy and practice. Health literacy interventions for Indonesian migrant workers should be occupationally targeted, particularly for domestic workers and babysitters who may have fewer opportunities for direct exposure to health-related information. Consular services, migrant worker organizations, healthcare providers, and employers should collaborate to provide Indonesian-language, culturally appropriate, and easily accessible health information. Health literacy promotion could also be integrated into pre-departure training, in-service migrant worker education, community outreach programs, and peer-based support networks. In addition, improving health literacy requires attention to structural barriers, including limited rest days, long working hours, language barriers, and difficulties navigating the host-country healthcare system.

The findings should be interpreted in light of the study's limitations, including the small sample size, non-probability sampling, reliance on self-reported data, single-country setting, cross-sectional design, and unmeasured confounders. Future research should involve larger and more representative samples, include longitudinal or mixed-methods designs, and examine additional determinants such as language proficiency, digital health literacy, social integration, employer support, and healthcare-seeking experiences. Comparative studies across different host countries would also help clarify how migration contexts and healthcare systems shape health literacy among Indonesian migrant workers.

In conclusion, this study suggests that health literacy among Indonesian migrant workers is not merely an individual attribute but a socially and occupationally shaped capability. Addressing health literacy gaps in this population requires both targeted education and broader structural support to ensure that migrant workers can access, understand, and use health information effectively.

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Conflict of interest statement

All authors declare no conflict of interest.

Authors' contributions

All authors have the equal contribution.

References

[1] United Nations Publications. World Migration Report 2018. United Nations Publications; 2018.

[2] Hunter P. The refugee crisis challenges national health care systems: Countries accepting large numbers of refugees are struggling to meet their health care needs, which range from infectious to chronic diseases to mental illnesses. EMBO Reports 2016;17:492-5. https://doi.org/10.15252/embr.201642171.

[3] Castañeda H, Holmes SM, Madrigal DS, Young M-ED, Beyeler N, Quesada J. Immigration as a Social Determinant of Health. Annu Rev Public Health 2015;36:375-92. https://doi.org/10.1146/annurev-publhealth-032013-182419.

[4] Wickramage K, Vearey J, Zwi AB, Robinson C, Knipper M. Migration and health: a global public health research priority. BMC Public Health 2018;18:987. https://doi.org/10.1186/s12889-018-5932-5.

[5] Chan J, Dominguez G, Hua A, Garabiles M, Latkin CA, Hall BJ. The social determinants of migrant domestic worker (MDW) health and well-being in the Western Pacific Region: A Scoping Review. PLOS Glob Public Health 2024;4:e0002628. https://doi.org/10.1371/journal.pgph.0002628.

[6] Afsah YR, Kaneko N. Exploring cervical cancer screening awareness, beliefs, barriers, and practices among Indonesian Muslim women in Japan: a qualitative study. BMC Public Health 2025;25:1084. https://doi.org/10.1186/s12889-025-22285-3.

[7] Martadewi FA, Sofiani E, Erisona DS, Eldurr SN, Kunsputri FA. Understanding Emergency Dental Health Literacy Among Indonesian Migrants in Singapore: A Cross?Sectional Survey. Media Publikasi Promosi Kesehatan Indonesia (MPPKI) 2025;8:1165-80. https://doi.org/10.56338/mppki.v8i10.8222.

[8] Angreni DKD. Social Network Analysis of Indonesia Migrant Workers in Hong Kong: Study Social Integration Between Health Care and "KOTKIHO." International j of Public Administration Stud 2022;2:07. https://doi.org/10.29103/ijpas.v2i1.7854.

[9] Kusdarini E, Puspitasari CD, Sakti SWK, Wahyuni PM. The Urgency of Legal Literacy for Indonesian Migrant Workers through Distance Education. Fiat Justisia 2021;15:399-416. https://doi.org/10.25041/fiatjustisia.v15no4.2317.

[10] Nasution MA. Mobilitas tenaga kerja indonesia ke luar negeri dandampaknya terhadap diri migran Suatu Tinjauan Awal terhadap Kasus Buruh Bangunan di Kuala Lumpur. Populasi 1998;9:59-77. https://doi.org/10.22146/jp.11811.

[11] Sørensen K, Pelikan JM, Röthlin F, Ganahl K, Slonska Z, Doyle G, Fullam J, Kondilis B, Agrafiotis D, Uiters E, Falcon M, Mensing M, Tchamov K, Broucke SVD, Brand H. Health literacy in Europe: comparative results of the European health literacy survey (HLS-EU). Eur J Public Health 2015;25:1053-8. https://doi.org/10.1093/eurpub/ckv043.

[12] Tavakoly Sany SB, Doosti H, Mahdizadeh M, Orooji A, Peyman N. The Health Literacy Status and Its Role in Interventions in Iran: A Systematic and Meta-Analysis. Int J Environ Res Public Health 2021;18:4260. https://doi.org/10.3390/ijerph18084260.

[13] Bánfai-Csonka H, Betlehem J, Deutsch K, Derzsi-Horváth M, Bánfai B, Finánczy J, Podráczky J, Csima M. Health Lit-

eracy in Early Childhood: A Systematic Review of Empirical Studies. Children 2022;9:1131. https://doi.org/10.3390/children9081131.

[14] Charoghchian Khorasani E, Tavakoly Sany SB, Tehrani H, Doosti H, Peyman N. Review of Organizational Health Literacy Practice at Health Care Centers: Outcomes, Barriers and Facilitators. Int J Environ Res Public Health 2020;17:7544. https://doi.org/10.3390/ijerph17207544.

[15] World Health Organization. Regional Office for Europe, Sørensen K, Trezona A, Levin-Zamir D, Kosir U, Nutbeam D. Transforming health systems and societies by investing in health literacy policy and strategy. Public Health Panorama 2019;5:259-63.

[16] Griffey RT, Kennedy SK, D'Agostino McGowan L, Goodman M, Kaphingst KA. Is low health literacy associated with increased emergency department utilization and recidivism? Acad Emerg Med 2014;21:1109-15. https://doi.org/10.1111/acem.12476.

[17] Jafari A, Tavakoly Sany SB, Peyman N. The Status of Health Literacy in Students Aged 6 to 18 Old Years: A Systematic Review Study. Iran J Public Health 1 March 2021. https://doi.org/10.18502/ijph.v50i3.5584.

[18] Keim-Malpass J, Letzkus LC, Kennedy C. Parent/caregiver health literacy among children with special health care needs: a systematic review of the literature. BMC Pediatr 2015;15:92. https://doi.org/10.1186/s12887-015-0412-x.

[19] Khorasani EC, Peyman N, Esmaily H. Effect of education based on the theory of self-efficacy and health literacy strategies on exclusive breastfeeding: A randomized clinical trial. Koomesh 2019;21:633-8.

[20] Rasu RS, Bawa WA, Suminski R, Snella K, Warady B. Health Literacy Impact on National Healthcare Utilization and Expenditure. Int J Health Policy Manag 2015;4:747-55. https://doi.org/10.15171/ijhpm.2015.151.

[21] Shahid R, Shoker M, Chu LM, Frehlick R, Ward H, Pahwa P. Impact of low health literacy on patients' health outcomes: a multicenter cohort study. BMC Health Serv Res 2022;22:1148. https://doi.org/10.1186/s12913-022-08527-9.

[22] Oktavianus J, Sun Y, Lu F. Understanding Health Information Behaviors of Migrant Domestic Workers during the COVID-19 Pandemic. Int J Environ Res Public Health 2022;19:12549. https://doi.org/10.3390/ijerph191912549.

[23] Christy SM, Gwede CK, Sutton SK, Chavarria E, Davis SN, Abdulla R, Ravindra C, Schultz I, Roetzheim R, Meade CD. Health Literacy among Medically Underserved: The Role of Demographic Factors, Social Influence, and Religious Beliefs. J Health Commun 2017;22:923-31. https://doi.org/10.1080/10810730.2017.1377322.

[24] Schaeffer D, Berens E-M, Vogt D. Health Literacy in the German Population. Dtsch Arztebl Int 2017;114:53-60. https://doi.org/10.3238/arztebl.2017.0053.

[25] Cheong P-L, Wang H, Cheong W, Lam MI. Health Literacy among Filipino Domestic Workers in Macao. Healthcare 2021;9:1449. https://doi.org/10.3390/healthcare9111449.

[26] Kosiyaporn H, Julchoo S, Sinam P, Phaiyarom M, Kunpeuk W, Pudpong N, Suphanchaimat R. Health Literacy and Its Related Determinants in Migrant Health Workers and Migrant Health Volunteers: A Case Study of Thailand, 2019. Int J Environ Res Public Health 2020;17:2105. https://doi.org/10.3390/ijerph17062105.

[27] Novrinda H, Han D-H. Oral health inequality among Indonesian workers in South Korea: role of health insurance and discrimination factors. BMC Oral Health 2022;22:22. https://doi.org/10.1186/s12903-022-02050-3.

[28] Kang SJ, Hyung NK. Trends and Level in Health Literacy Research on Immigrants in Korea: A Literature Review. J Korean Acad Community Health Nurs 2020;31:322. https://doi.org/10.12799/jkachn.2020.31.3.322.

[29] Duong TV, Aringazina A, Kayupova G, Nurjanah, Pham TV, Pham KM, Truong TQ, Nguyen KT, Oo WM, Su TT, Majid HA, Sørensen K, Lin I-F, Chang Y, Yang S-H, Chang PWS. Development and Validation of a New Short-Form Health Literacy Instrument (HLS-SF12) for the General Public in Six Asian Countries. Health Lit Res Pract 2019;3:e91-102. https://doi.org/10.3928/24748307-20190225-01.

[30] Sørensen K, Van Den Broucke S, Pelikan JM, Fullam J, Doyle G, Slonska Z, Kondilis B, Stoffels V, Osborne RH, Brand H. Measuring health literacy in populations: illuminating the design and development process of the European Health Literacy Survey Questionnaire (HLS-EU-Q). BMC Public Health 2013;13:948. https://doi.org/10.1186/1471-2458-13-948.

[31] Milanti A, Chan DNS, Choi KC, So WKW. eHealth literacy of migrant domestic workers in Hong Kong in the COVID-19 pandemic: A mixed methods study. PLoS ONE 2024;19:e0296893. https://doi.org/10.1371/journal.pone.0296893.

[32] Mo PKH, Xie L, Mak WWS. Is inadequate health literacy associated with worse health outcomes among Chinese individuals with depression? Health Promot Int 2023;38:daad042. https://doi.org/10.1093/heapro/daad042.

[33] Anggaunitakiranantika A. Social Networks: The Survival Strategy Of Indonesian Migrant Workers In Hong Kong. Komunitas Int J Indones Soc Cult 2021;13:100-7. https://doi.org/10.15294/komunitas.v13i1.27021.

[34] Bernadas JMAC, Piocos CM, Vilog RBT. Community organizations and ethnic media working with foreign household service workers: Applying communication infrastructure theory to migrant health. Commun Public 2023;8:222-36. https://doi.org/10.1177/20570473231177791.

[35] Ho KHM, Smith GD. A discursive paper on the importance of health literacy among foreign domestic workers during outbreaks of communicable diseases. J Clin Nurs 2020;29:4827-33. https://doi.org/10.1111/jocn.15495.

[36] Wahyudi I, Allmark P. Indonesian migrant workers in Hong Kong: Smartphone culture and activism. Masyarakat Kebudayaa 2020;33:122. https://doi.org/10.20473/mkp.V33I22020.122-133.

[37] Garner SL, Wong CL, Young P, Fendt M, Hitchcock J, George CE. Mobile Health to Improve Hypertension and Diabetes Health Literacy Among Asian Indian Migrants to Hong Kong. Comput Inform Nurs 2021;40:269-77. https://doi.org/10.1097/CIN.0000000000000807.

[38] Zhang F, Or PPL, Chung JWY. How different health literacy dimensions influences health and well-being among men and women: The mediating role of health behaviours. Health Expect 2021;24:617-27. https://doi.org/10.1111/hex.13208.

[39] Jia H. Language barriers and health inequality: Examining access to healthcare for migrants with chronic illnesses in China. Public Health 2025;240:148-53. https://doi.org/10.1016/j.puhe.2025.01.037.

[40] Liu S, Hu CXJ, Mak S. Comparison of Health Status and Health Care Services Utilization between Migrants and Natives of the Same Ethnic Origin–The Case of Hong Kong. Int J Environ Res Public Health 2013;10:606-22. https://doi.org/10.3390/ijerph10020606.

[41] Wong WC, Ho PS, Liang J, Holroyd EA, Lam CL, Pau AM. Road to better health and integration: a Delphi study on health service models for Hong Kong migrants. Int J Equity Health 2014;13:127. https://doi.org/10.1186/s12939-014-0127-x.

[42] Xie Y, Ma M, Zhang Y, Tan X. Factors associated with health literacy in rural areas of Central China: structural equation model. BMC Health Serv Res 2019;19:300. https://doi.org/10.1186/s12913-019-4094-1.

[43] Milner MS, Beckman KA, Luchs JI, Allen QB, Awdeh RM, Berdahl J, Boland TS, Buznego C, Gira JP, Goldberg DF, Goldman D, Goyal RK, Jackson MA, Katz J, Kim T, Majmudar PA, Malhotra RP, McDonald MB, Rajpal RK, Raviv T, Rowen S, Shamie N, Solomon JD, Stonecipher K, Tauber S, Trattler W,

Walter KA, Waring GO, Weinstock RJ, Wiley WF, Yeu E. Dysfunctional tear syndrome: dry eye disease and associated tear film disorders – new strategies for diagnosis and treatment. Curr. Opin. Ophthalmol 2017;28:3-47. https://doi.org/10.1097/01.icu.0000512373.81749.b7.

[44] Wu Y, Wang L, Cai Z, Bao L, Ai P, Ai Z. Prevalence and Risk Factors of Low Health Literacy: A Community-Based Study in Shanghai, China. IJERPH 2017;14:628. https://doi.org/10.3390/ijerph14060628.

[45] Chang Y-W, Li T-C, Chen Y-C, Lee J-H, Chang M-C, Huang L-C. Exploring Knowledge and Experience of Health Literacy for Chinese-Speaking Nurses in Taiwan: A Cross-Sectional Study. nt J Environ Res Public Health 2020;17:7609. https://doi.org/10.3390/ijerph17207609.

[46] Güner MD, Ekmekci PE. Health Literacy Level of Casting Factory Workers and Its Relationship With Occupational Health and Safety Training. Workplace Health Saf 2019;67:452-60. https://doi.org/10.1177/2165079919843306.

[47] Li G, Qi Z, Yu W, Wang Q, Hou H, Miao C, Yan W, Gao X. Factors influencing utilization of healthcare services for internal migrant older adults in Xuzhou, China: based on Anderson's model. Front Public Health 2024;12. https://doi.org/10.3389/fpubh.2024.1378790.

[48] Novrinda H, Han D-H. Oral health inequality among Indonesian workers in South Korea: role of health insurance and discrimination factors. BMC Oral Health 2022;22:22. https://doi.org/10.1186/s12903-022-02050-3.

[49] Wang X, Liu J, Zhu J, Bai Y, Wang J. The association between social integration and utilization of primary health care among migrants in China: a nationwide cross-sectional study. Int J Equity Health 2023;22:210. https://doi.org/10.1186/s12939-023-02018-x.

[50] Mancuso L. Overcoming health literacy barriers: a model for action. J Cult Divers 2011;18:60-5.

[51] Silitonga HTH, Winarso H, I'tishom R. The effectiveness of reproductive health education model among indonesian women migrant workers. Mal J Public Health Med 2023;23:237-44. https://doi.org/10.37268/mjphm/vol.23/no.2/art.2133.

[52] Gao X, Chan CW, Mak SL, Ng Z, Kwong WH, Kot CCS. Oral Health of Foreign Domestic Workers: Exploring the Social Determinants .J Immigr Minor Health 2013;16:926-33. https://doi.org/10.1007/s10903-013-9789-5.

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HEALTH PROMOTION

Smoking and Sport: A CrossSectional Study Among Competitive Athletes in Southern Italy. "Salento Smoke Study"

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Keywords

Athletes • Smoking • Tobacco • Cardiovascular Risk • Sport Type

Summary

Background. *Smoking habits remain prevalent even among competitive athletes, despite their well-documented negative impact on cardiovascular health and athletic performance.*

Aim. *To assess the prevalence of tobacco use among competitive athletes in a southern Italian region and explore its association with demographic characteristics, sport type, and cardiovascular risk factors.*

Materials and methods. *A cross-sectional survey was conducted among 1,348 athletes residing in the Salento peninsula (Southern Italy), with a mean age of 38.8±13.9 years. A structured questionnaire collected information on sporting activity, tobacco use, electronic nicotine delivery systems (ENDS), and cardiovascular risk factors.*

Results. *Overall, 24.4% of athletes reported smoking. Smoking prevalence was significantly higher among athletes with at least one cardiovascular risk factor compared with those without (31.2% vs. 22.1%, p=0.01). Strength athletes showed a higher prevalence of smoking than endurance athletes (31.9% vs. 17.1%, p=0.001), and athletes participating in team sports smoked more frequently than those in individual sports (34.0% vs. 19.7%, p<0.01). Smoking was more prevalent among older athletes than younger athletes (25.9% vs. 21.6%, p=0.023). ENDS were used by 10.3% of athletes; among ENDS users, a higher proportion were younger athletes (65% vs. 39%, p=0.001) and women (55% vs. 43%, p=0.02). Consistent with these findings, multivariable analysis showed that smoking was independently associated with the presence of ≥1 cardiovascular risk factor (OR 2.46), participation in team sports (OR 1.79), and older age (>35 years: OR 1.54), while endurance athletes (OR 0.62) and elite competitors (OR 0.58) exhibited lower odds of smoking.*

Conclusion. *Tobacco use remains common among competitive athletes and appears comparable to estimates from the general population. Smoking is more frequent among strength athletes and among those with cardiovascular risk factors. ENDS use is particularly widespread among younger athletes and women. These findings highlight the need for targeted cardiovascular prevention strategies even within athletic populations.*

Introduction

Several studies have reported that the prevalence of smoking among young competitive athletes ranges between 20% and 25%, with a growing preference for electronic nicotine delivery systems (ENDS) [1]. In the United States, the National College Health Assessment found similar rates of tobacco use among athletic and non-athletic college students (27.6% *vs*. 29.5%). Comparable findings were observed in South Africa, where smoking prevalence among young athletes and non-athletes was 22.2% and 18.6%, respectively [2]. Much lower rates have been reported among Olympic athletes, with a prevalence of 11.4% [3]. In Europe, as well as in Italy, nearly a quarter of the population (24%) are smokers [4]. An observational study of about 60,000 Italian athletes using a doping survey has shown the presence of nicotine in 23% of athletes [5], similar to the general population.

Cigarette smoking is well-known to be linked to an increased risk of cardiovascular disease [6-7], lung diseases such as chronic obstructive pulmonary disease (COPD) [8] and cancer [9]. Beyond its impact on morbidity and mortality, smoking negatively affects both quality of life and athletic performance. Studies on young athletes have shown that nonsmokers exhibit significantly better cardiopulmonary function during and after exercise compared with smokers [10, 11]. Exposure to passive smoking has also been associated with impaired respiratory parameters in young athletic populations [12, 13].

The prevalence of smoking is influenced by multiple factors, including the marketing strategies of the tobacco industry, national awareness campaigns, and the role of

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local institutions and educational systems [4] Moreover, smoking patterns among young people and athletes have evolved over time, particularly with the emergence of new nicotine delivery systems [20]. In this context, the present study aims to assess the prevalence of smoking among competitive athletes of all adult age groups in the Salento peninsula, a specific geographical area of southern Italy, and to explore its distinctive characteristics, including the use of traditional cigarettes and ENDS.

Materials and methods

Study design

This cross-sectional observational study was conducted at the "Cardiomed" medical and research center in Maglie (Lecce), the "MS Plan" medical center in Lecce, and the Cardiology Department of "Villa Verde" Hospital in Taranto, from March 2024 to March 2025. Competitive athletes aged 18 years or older residing in the Salento peninsula, a well-defined geographical area in southern Italy, were recruited. Participants were enrolled during routine medical evaluations required for the annual renewal of competitive sports eligibility. Only a small number of athletes declined participation, resulting in a participation rate close to 100%.

The study was approved by the Regional Ethics Committee and conducted in accordance with the Declaration of Helsinki, the Belmont Report, and International Conference on Harmonisation-Good Clinical Practice (ICH-GCP) guidelines. All participants provided written informed consent.

Each athlete completed a structured questionnaire covering demographic characteristics, medical history, type of sport, and smoking habits, including duration of use, type of product, and daily consumption. Athletes who reported smoking at least once in the previous 30 days were classified as current smokers [13]. ENDS use was classified as exclusive (use of ENDS only) or dual (combined use of ENDS and traditional cigarettes), in accordance with standard epidemiological definitions.

All demographic, clinical, and anamnestic data were entered into a dedicated database. Prevalence analyses and subgroup comparisons were then performed. Smoking prevalence was evaluated according to sport type: strength (*e.g.,* weightlifting, strongman, powerlifting), endurance (*e.g.,* cycling, running, swimming, triathlon), and mixed strength/endurance (*e.g.,* football, volleyball, basketball, tennis, boxing). Only athletes whose sporting discipline could be clearly classified as strength or endurance, or predominantly characterized by one of these two components, were included in the correlation analysis. Disciplines with overlapping characteristics were excluded from the correlation analysis.

Additional subgroup analyses included individual *vs.* team sports, sex, and competitive level (elite *vs.* amateur). Smoking habits were further characterized by type of product used (traditional cigarettes, electronic nicotine delivery systems) and quantity consumed to ensure alignment with the reported results.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 30. Descriptive statistics included continuous variables, such as age and smoking duration, which were summarized with mean and standard deviation, while categorical variables, such as sport type, sex, and smoking status, were expressed as frequencies and percentages.

For bivariate associations, the Pearson chi-square test was used to compare smoking prevalence across distinct groups, such as athletes with and without cardiovascular risk factors, strength *vs.* endurance athletes, and team *vs.* individual sport athletes. The Student's t-test was applied to compare the mean age between smokers and non-smokers. Normality assumptions for continuous variables were checked using the Shapiro-Wilk test, and Levene's test for equality of variances was conducted to ensure homogeneity of variances between groups. All continuous variables met normality assumptions.

A multivariable logistic regression analysis was performed to identify independent factors associated with smoking. The model included variables such as age group (>35 *vs.* 18-35 years), sex (male *vs.* female), sport type (team *vs.* individual), sport discipline (strength *vs.* endurance), competitive level (elite *vs.* amateur), and the presence of at least one cardiovascular risk factor. The age cut-off of 35 years was selected because, in many of the sport disciplines represented in our cohort, particularly endurance sports athletes aged ≥35 years are commonly classified within "Master" categories. This threshold therefore provides a meaningful and widely used distinction in competitive settings and allows for a more intuitive interpretation of age-related differences. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to estimate the strength of associations. A two-tailed $p\text{-value}<0.05$ was considered statistically significant for all analyses.

Results

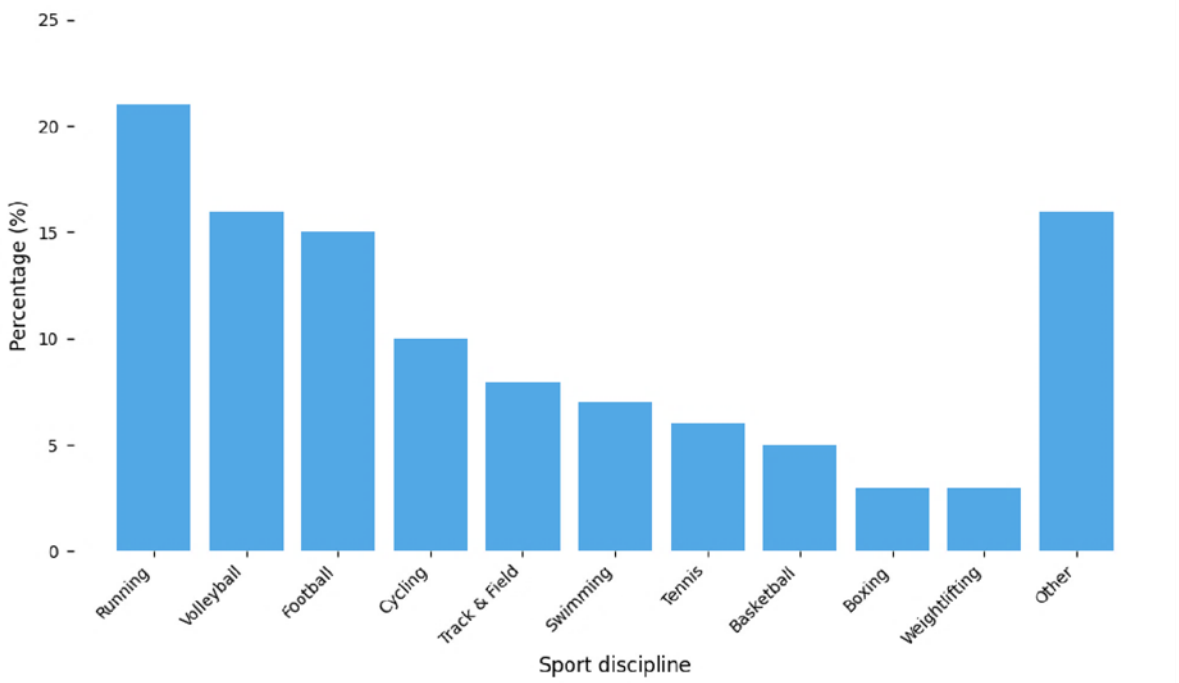
Characteristics of the population and type of sport

A total of 1,348 athletes participated in the study (Tab. I). The mean age was 38.7±13.8 years, with 964 males (71.5%) and 384 females (28.5%). The mean age of smokers was 39.1±13.7 years, compared with 38.6±13.9 years among non-smokers, with no statistically significant difference between the two groups ($p=0.42$). Athletes were divided into two age groups: younger (18-35 years, 41.5%, n=560) and older (>35 years, 58.5%, n=788).

The prevalence of each sport type is presented in Figure 1. Individual sports were more prevalent than team sports (62.3%, n=786 *vs*. 39.4%, n=497). For the analysis by sport type, only athletes whose sporting activity could be clearly classified as strength or endurance sports were included. Among these, 9.2% (n=116) participated in strength sports, and 39.7% (n=501) participated in endurance sports.

Among individual sports, running and cycling were

Fig. 1. Distribution of athletes by type of sport (N=1,348).



the most represented disciplines, while in team sports football and volleyball predominated. Overall, running, volleyball, football, cycling, and athletics together represented approximately 70% of the study population. Most athletes had a medium-level competitive profile (regional/national competitions), whereas 98 athletes (7.2%) were classified as elite or international level. Smoking was reported by 324 athletes (24.4%), while 22 athletes (1.6%) were former smokers and 1,002 (74.0%) were never smokers. Among current smokers, 176 (57%) used traditional cigarettes and 148 (43%) used electronic nicotine delivery systems (ENDS). Regarding daily cigarette consumption among smokers, 102 (58%) reported smoking fewer than 10 cigarettes per day, 60 (34%) smoked 10-20 cigarettes, and 14 (8%) smoked more than 20 cigarettes per day.

Cardiovascular risk profile of the population

The prevalence of cardiovascular risk factors in the population was as follows: hypertension in 48 athletes (3.6%), hypercholesterolemia in 64 athletes (4.7%), overweight or obesity in 36 athletes (2.7%), diabetes mellitus in 20 athletes (1.5%), a history of atrial fibrillation (AF) in 20 athletes (1.5%), and a family history of ischemic heart disease (CAD) in 64 athletes (4.7%). Overall, 282 athletes (20.9%) had at least one cardiovascular risk factor (Tab. I).

Data are presented as n (%) or mean±SD. Cardiovascular risk factors, type of sport, team *vs.* individual sport, and smoking habits are shown. Of the 1,348 athletes, 1,261 were classified into three groups based on the type of sport they practiced.

Analysis of smoking habits

Overall, 324 athletes (24.4% of the study population) were classified as current smokers, 22 (1.6%) as former smokers, and 1,002 (74.0%) as never smokers. ENDS were used by 139 athletes, corresponding to 10.3% of the total study population and 43% of current smokers. Although smoking prevalence was slightly higher among men, the difference was not statistically significant (237 men, 24.5% *vs.* 87 women, 22.6%; p=0.24).

On average, athletes started smoking at 16.9±2.9 years of age, with a mean smoking duration of 10±7 years. Regarding daily consumption, 102 smokers (58%) consumed fewer than 10 cigarettes, 60 (34%) smoked 10-20, and 14 (8%) smoked more than 20 cigarettes per day.

Associations between smoking habits and selected variables

Risk factors and smoking habits

When the smoking population was divided according to the presence of at least one cardiovascular risk factor, athletes with at least one risk factor showed a higher propensity to smoke. Among athletes without risk factors, 236/1066 (22.1%) were smokers, whereas among those with at least one risk factor, 88/282 (31.2%) were smokers. Chi-square tests confirmed that smoking prevalence was significantly higher among athletes with at least one cardiovascular risk factor compared to those without (p=0.01) (Fig. 2).

Bar chart showing the percentage of smokers and non-smokers in athletes with and without cardiovascular risk factors. Smokers are represented by the red portion, and non-smokers by the blue portion.

Tab. I. Demographic and clinical characteristics of the study population (N=1,348).

Characteristic	N (%)
Age, years	38.7±13.8
Age groups	
18–35	560 (41.5)
>35	788 (58.5)
Gender	
Male	964 (71.5)
Female	384 (28.5)
Cardiovascular risk factors	
Hypertension	48 (3.6)
Hypercholesterolemia	64 (4.7)
Overweight/Obesity	36 (2.7)
CAD family history	64 (4.7)
History of AF	20 (1.5)
Diabetes Mellitus	20 (1.5)
Type of sport	
Strength	116 (9.2)
Endurance	501 (39.7)
Strength/Endurance	644 (51.1)
Team *vs.* Individual sport	
Team	497 (39.4)
Individual	786 (62.3)
Competitive Level	
Amateur	1,263 (92.8%)
Elite	98 (7.2%)
Smoking habit	
Smokers	324 (24.4)
Former smokers	22 (1.6)
Never smokers	1002 (74.0)
Tobacco use (among smokers)	
Traditional cigarettes	176 (57)
ENDS	148 (43)
Number of cigarettes (among smokers of traditional cigarettes)	
<10	102 (58)
10-20	60 (34)
>20	14 (8)

Fig. 2. Correlation between smoking habits and cardiovascular risk factors.

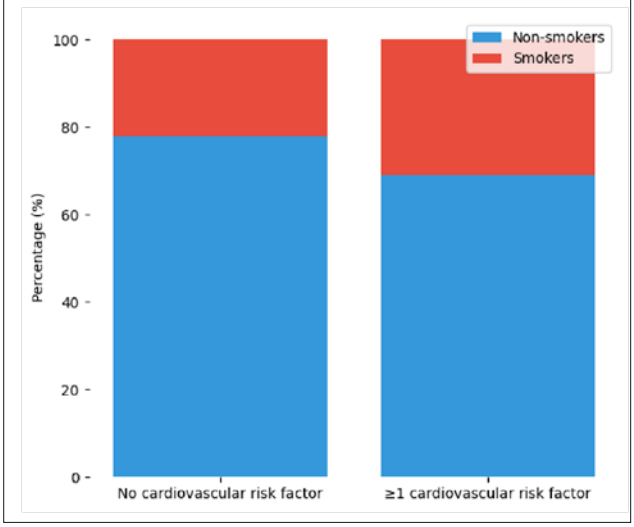
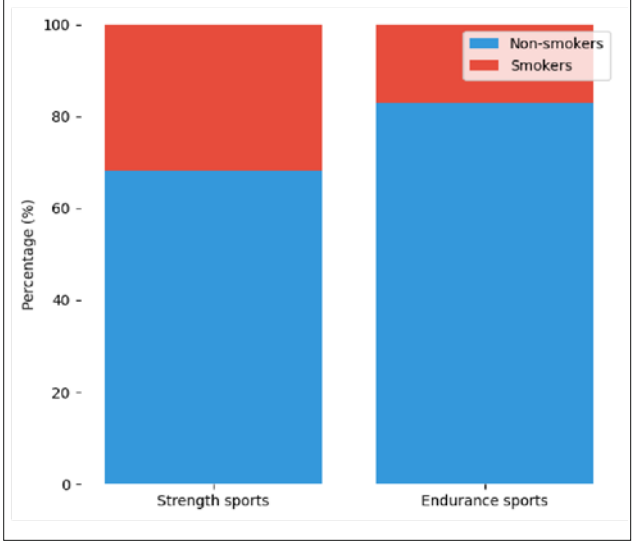


Fig. 3. Correlation between type of sport and smoking habits.



Type of sport (strength/endurance) and smoking habits

The analysis focused on the two clearly defined groups, strength and endurance athletes. Among athletes practicing strength sports, 37 out of 116 (31.9%) were current smokers. In endurance sports, smoking prevalence was significantly lower, with 85 out of 501 athletes (17.1%) reporting smoking habits. A comparison between the strength and endurance groups revealed a significant difference (31.9% *vs.* 17.1%, p=0.001), with strength athletes being more likely to smoke (Fig. 3).

Bar chart comparing the percentage of smokers and non-smokers in athletes practicing strength sports versus endurance sports. Smokers are represented by the red portion, and non-smokers by the blue portion.

Type of sport (individual or team) and smoking habits

Among athletes participating in team sports, 169 out of 497 (34.0%) were smokers, whereas 155 out of 786 (19.7%) of athletes in individual sports smoked. A statistical comparison between the two groups (individual *vs.* team sports) revealed a significant difference (p<0.01), with a higher prevalence of smoking among athletes who participate in team sports (Fig. 4).

Bar chart comparing the percentage of smokers and non-smokers in athletes practicing team or individual sports. Smokers are represented by the red portion, and non-smokers by the blue portion.

Differences in relation to age and gender and use of ENDS.

When the groups were divided by age (younger athletes, 18-35 years old, and older athletes, over 35 years old), a higher prevalence of smoking was observed in the older group: 121 athletes aged 18-35 (21.6%) and 204 athletes aged >35 (25.9%), with a statistically significant difference (p=0.023). Among smokers, a higher incidence was

Fig. 4. Distribution of smokers and non-smokers among athletes practicing team or individual sports.

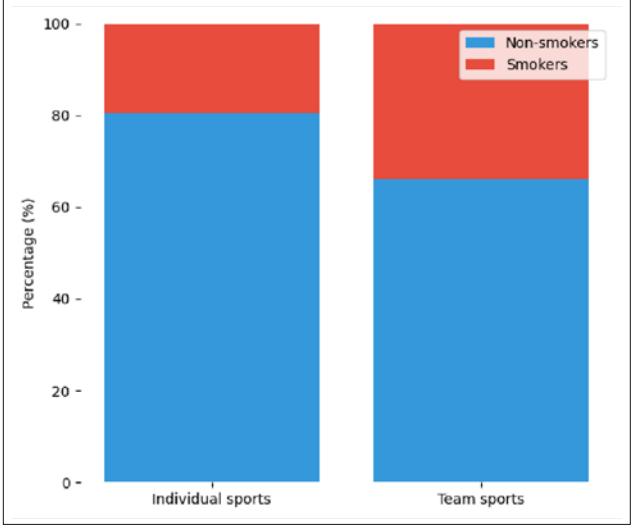
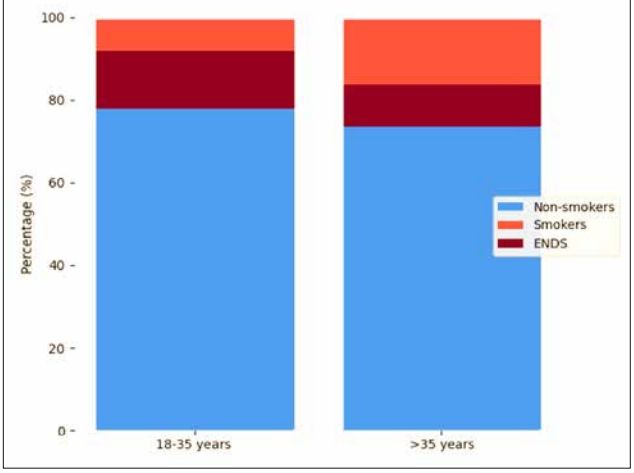


Fig. 5. Smoking habits among athletes by age, showing traditional cigarettes and electronic nicotine delivery systems (ENDS).



observed in men (n=236, 24.5%) than in women (n=88, 22.9%), although this difference was not statistically significant (p=0.248). Among current smokers, ENDS use accounted for 43% of cases and was more frequent among younger athletes (65% *vs.* 39%, p=0.001) and among women (55% *vs.* 43%, p = 0.02) (Fig. 5).

Multivariable Logistic Regression Analysis of Smoking Habits

To identify factors independently associated with current smoking status among competitive athletes, a multivariable logistic regression analysis was performed. Variables included in the model were: age group (>35 *vs.* 18-35 years), sex (male *vs.* female), type of sport (team *vs.* individual), sport discipline (strength *vs.* endurance), competitive level (elite *vs.* amateur), and presence of at least one cardiovascular risk factor. These variables were selected based on their significance in prior bivariate analyses (ttests and chisquare tests).

Tab. II. Multivariable logistic regression analysis for current smoking among competitive athletes.

Variable	OR	95% CI	*p-value*
Age >35 *vs.* 18–35 years	1.54	1.11-2.14	0.010
Male *vs.* Female	1.11	0.80-1.54	0.520
Team *vs.* Individual sport	1.79	1.28-2.50	0.001
Endurance *vs.* Strength sport	0.62	0.44-0.87	0.006
Elite *vs.* Amateur	0.58	0.39-0.86	0.007
≥1 Cardiovascular risk factor *vs.* None	2.46	1.65-3.67	<0.001

As shown in Table II, athletes with at least one cardiovascular risk factor had significantly greater odds of being current smokers compared with those without risk factors (OR=2.46, 95% CI: 1.65-3.67, p<0.001). Similarly, participation in team sports was independently associated with higher odds of smoking compared with individual sports (OR=1.79, 95% CI: 1.28-2.50, p = 0.001). Older age (>35 years) was also a significant predictor of smoking (OR=1.54, 95% CI: 1.11-2.14, p=0.01). In contrast, endurance athletes had lower odds of smoking compared with strength athletes (OR=0.62, 95% CI: 0.44-0.87, p=0.006), and elite athletes were less likely to be smokers than amateur competitors (OR=0.58, 95% CI: 0.39-0.86, p=0.007). Sex was not independently associated with smoking status (OR = 1.11, 95% CI: 0.80-1.54, p=0.52) (Fig. 6). These results confirm that the associations observed in univariate analyses persist when adjusting for multiple factors, and they highlight three key subgroups of athletes, namely those with cardiovascular risk factors, older athletes, and team sport participants, who are at an increased likelihood of smoking.

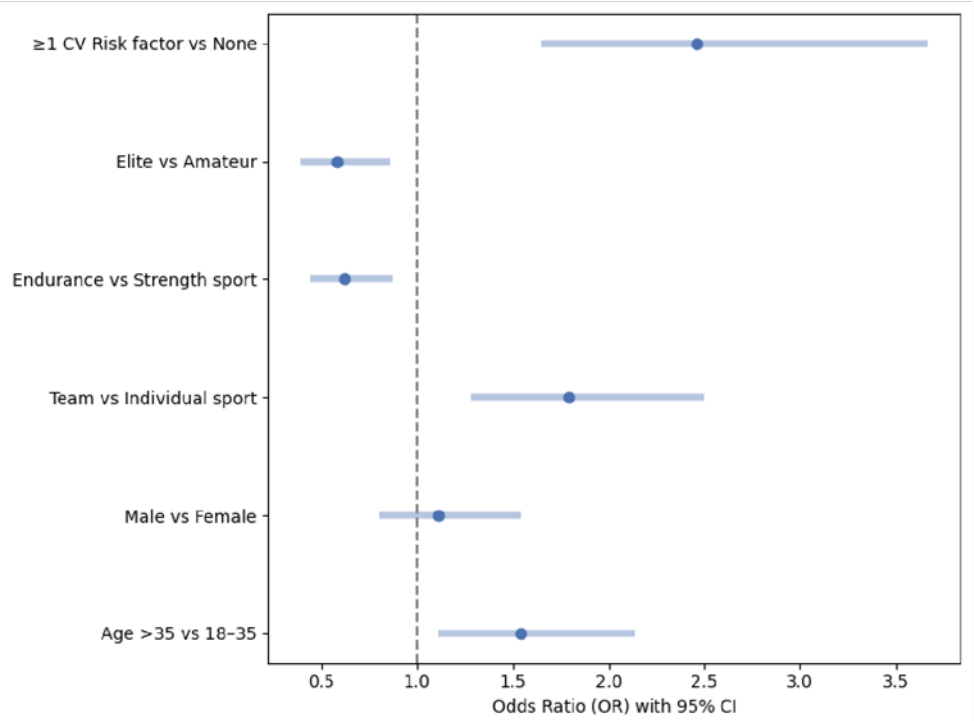
Discussion

This cross-sectional study found a relatively high prevalence of smoking among competitive athletes undergoing fitness certification in the Salento peninsula over a one-year period. The observed prevalence of current smokers (24.4%) aligns closely with estimates from the general Italian population [4, 5]. Interestingly, the subgroup of elite athletes showed a markedly lower prevalence of smoking (10.5%), consistent with data reported among Olympic-level competitors [3]. This suggests that higher-level athletes may possess greater awareness of the detrimental effects of smoking on performance and health or may be subject to stricter health monitoring and preventive measures.

Smoking and Type of Sport

Our findings indicate that athletes engaged in predominantly strength-based sports exhibited a higher prevalence of smoking compared with endurance athletes. This difference may reflect the more immediate and detrimental effects of smoking on aerobic capacity, which is crucial for endurance performance. Endurance disciplines require sustained oxygen delivery and cardiovascular efficiency, making the negative

Fig. 6. Forest plot displaying the odds ratios for factors associated with smoking among competitive athletes. Odds Ratio (OR) and 95% Confidence intervals (CI) are shown.



physiological consequences of smoking more readily apparent during training and competition [17].

Furthermore, smoking was more prevalent among athletes participating in team sports compared with individual sports, a trend supported by previous literature [18, 19]. The higher smoking rates in team sports may be influenced by social dynamics, including peer emulation, shared group behaviors, and the possibility of "masking" individual habits within a team setting. Observational studies indicate that athletes who participate in team sports multiple times per week tend to report higher tobacco use, possibly reflecting both social modeling and decreased personal accountability for performance outcomes. These findings suggest that the social environment inherent to team sports, including peer influence and shared behavioral norms, may play a relevant role in shaping smoking behaviors among athletes.

Age, Gender, and Smoking Patterns

Age at smoking initiation remains a crucial determinant of nicotine dependence and subsequent cessation success. Individuals who begin smoking before 21 years are more prone to develop dependence and less likely to quit successfully later in life [20, 21]. In our cohort, older athletes (>35 years) exhibited a higher prevalence of smoking (25.9%) compared with younger athletes (18-35 years: 21.6%), though smoking remained common among the younger group. The mean age of smoking initiation in our population was relatively early (16.9±2.9 years).

Notably, younger athletes were more likely to use electronic nicotine delivery systems (ENDS), whereas older athletes predominantly smoked traditional cigarettes. This pattern highlights the need for targeted preventive strategies focusing on youth, aimed at delaying initiation and reducing long-term nicotine dependence. Historically, male athletes have displayed higher smoking prevalence; however, gender differences have narrowed over time in many regions [24]. Our study confirmed a slightly higher propensity among men, but this difference did not reach statistical significance.

Smoking and Cardiovascular Risk Factors

Prior studies suggest that athletes may underestimate the importance of maintaining optimal lifestyle behaviors, including avoidance of tobacco [16]. Recent Italian research demonstrates that cardiovascular risk factors exist even among competitive athletes, including those at elite levels [26]. Our data show that athletes with at least one cardiovascular risk factor were significantly more likely to smoke, indicating a potential misperception of personal risk and underestimation of smoking-related cardiovascular hazards. These findings underscore the necessity of targeted educational efforts for at-risk subgroups.

Multivariable Regression: Independent Predictors of Smoking

Multivariable logistic regression allowed us to identify factors independently associated with current smoking. Athletes with at least one cardiovascular risk factor had approximately 2.5 times higher odds of being current smokers. Team sport participation and older age were also independently associated with increased smoking likelihood. Conversely, endurance athletes and elite-

level competitors exhibited lower odds of smoking. Sex was not an independent predictor in the adjusted model. These regression findings provide nuanced insights beyond univariate analyses, pinpointing high-risk subgroups; athletes with cardiovascular risk factors, older participants, and team sport athletes who may benefit most from targeted interventions. The protective role of endurance training and elite-level competition suggests that enhanced awareness of performance consequences and intensive monitoring may effectively reduce smoking prevalence.

Implications for Prevention and Health Promotion

The persistence of smoking among competitive athletes, especially those with cardiovascular risk factors, emphasizes the critical need for tailored educational and preventive strategies. Interventions should focus on risk communication, highlighting both health and performance-related consequences. In this context, team-based initiatives, age-specific programs, and individualized counseling for high-risk athletes may enhance effectiveness. Addressing ENDS use among younger athletes is particularly important to prevent early nicotine dependence and potential progression to traditional tobacco products. In organized sports settings, these findings support the implementation of targeted preventive strategies, including brief educational interventions during routine eligibility evaluations, teambased awareness initiatives, and counseling programs aimed at younger athletes and those with cardiovascular risk factors. Such approaches may help reinforce risk perception, promote healthier behaviors, and reduce both traditional cigarette use and ENDS consumption within athletic environments.

Limitations

Several limitations warrant consideration. First, the cross-sectional design precludes causal inference between smoking and observed characteristics. Second, the sample was predominantly mid-level athletes, with elite competitors underrepresented, potentially limiting generalizability. Third, ENDS use was categorized broadly without differentiation between device types, nicotine concentrations, or frequency of use. In addition, training volume, weekly exercise intensity, and total workload were not quantitatively assessed and could not be included as covariates in the statistical analyses. Moreover, although the 35-year cut-off is commonly used to distinguish Master athletes in several sport disciplines, it may not apply uniformly across all sports. Therefore, this categorization may not fully capture age-related variability in disciplines adopting different thresholds. Finally, self-reported smoking behaviors may be subject to recall and social desirability bias.

Conclusion

The primary finding of this study is the confirmation of a high prevalence of smoking among competitive athletes, comparable to the general population. Notably, smoking was more common among athletes with existing cardiovascular risk factors, underscoring a significant gap in risk perception. These results highlight the importance of implementing tailored preventive strategies within the athletic community. Educational campaigns should emphasize both performance- and health-related consequences of smoking, employing models adapted to athletes' social and competitive contexts. Interventions could include targeted programs for youth, promotion of smoke-free team environments, and personalized counseling for athletes at higher cardiovascular risk. By addressing behavioral and awareness factors, these strategies have the potential to reduce tobacco use and optimize long-term health and athletic performance.

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

GDMDL, ZP, LS: Conceptualization; GDMDL, SR, ZP: Methodology; GDMLDL, MS: Formal analysis; GP, FC, AGR, GDMDL, MN, AS, GV, PP, MC, SS, LR: Investigation; GDMDL, GV: Data curation; GDMDL: Writing-original draft preparation; LS, SR, ZP: Writing-review and editing; LS, SR: Supervision. All authors have read and agreed to the published version of the manuscript.

References

[1] Gingiss PL, Gottlieb NH. A comparison of smokeless tobacco and smoking practices of university varsity and intramural baseball players. Addict Behav 1991;16:335-40. https://doi.org/10.1016/0306-4603(91)90024-6.

[2] Florence G, Janse van Vuren M, Derman W, Popperwell J, Kotzé-Hörstmann L. Lifestyle-related health risk behaviours among student athletes and non-athletes. J Prev Med Hyg

2021;62:E766-74. https://doi.org/10.15167/2421-4248/jpmh2021.62.3.1979.

[3] Alaranta A, Alaranta H, Holmila M, Palmu P, Pietilä K, Helenius I. Snuff use and smoking in Finnish Olympic athletes. Int J Sports Med 2006;27:581-6. https://doi.org/10.1055/s-2005-865917.

[4] Eurobarometer 2024. Attitudes of Europeans towards tobacco and related products. Special Eurobarometer 539. https://doi.org/10.2775/24151.

[5] Zandonai T, Botrè F, Berretta P, de la Torre X. Nicotine in sport: analysis from 60,802 doping control tests in Italy. Sports Med 2023;53:1273-9. https://doi.org/10.1007/s40279-023-01822-0.

[6] Facciolà A, Visalli G, D'Andrea G, Varvarà M, Santoro G, Cuffari R, Di Pietro A. Prevention of cardiovascular diseases and diabetes: importance of a screening program for the early detection of risk conditions in a target population. J Prev Med Hyg 2021;62:E360-7. https://doi.org/10.15167/2421-4248/jpmh2021.62.4.2360.

[7] Ezzati M, Henley SJ, Thun MJ, Lopez AD. Role of smoking in global and regional cardiovascular mortality. Circulation 2005;112:489-97. https://doi.org/10.1161/CIRCULATIONAHA.104.529958.

[8] Willemse BW, Postma DS, Timens W, Hacken NH. Impact of smoking cessation on respiratory symptoms and lung function. Eur Respir J 2004;23:464-76. https://doi.org/10.1183/09031936.04.00063204.

[9] Vineis P, Alavanja M, Buffler P, Fontham E, Franceschi S, Gao YT, Gupta PC, Hackshaw A, Matos E, Samet J, Sitas F, Smith J, Stayner L, Straif K, Thun MJ, Wichmann HE, Wu-Williams AH, Zaridze D, Peto R, Doll R. Tobacco and cancer: recent epidemiological evidence. J Natl Cancer Inst 2004;96:99-106. https://doi.org/10.1093/jnci/djh014.

[10] Jang DJ, Park SY, Kim MH, Cho JH, Roh HT. Effects of habitual smoking on cardiopulmonary function in taekwondo athletes. J Exerc Rehabil 2017;13:711-5. https://doi.org/10.12965/jer.1735102.551.

[11] Packa-Tchissambou B, Massamba A, Sone A, Bouenka J, Mabounda MT. Effect of smoking on cardiopulmonary capacities in young athletes. Sante 2001;11:161-6.

[12] Tsimoyianis GV, Sagani-Papastavrou M, Piachas PK. Passive smoking and pulmonary function in teenage athletes. Pediatrics 1987;80:32-6. https://doi.org/10.1542/peds.80.1.32.

[13] Goic-Barisic I, Erceg M, Goic-Barisic L. Influence of passive smoking on respiratory function in young athletes. Coll Antropol 2006;30:615-9.

[14] Miller MR, Crapo R, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, Enright P, van der Grinten CP, Gustafsson P, Jensen R, Johnson DC, MacIntyre N, McKay R, Navajas D, Pedersen OF, Pellegrino R, Viegi G, Wanger J. General considerations for lung function testing. Eur Respir J 2005;26:153-61. https://doi.org/10.1183/09031936.05.00034505.

[15] Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, Crapo R, Enright P, van der Grinten CP, Gustafsson P, Jensen R, Johnson DC, MacIntyre N, McKay R, Navajas D, Pedersen OF, Pellegrino R, Viegi G, Wanger J. Standardisation of spirometry. Eur Respir J 2005;26:319-38. https://doi.org/10.1183/09031936.05.00034805.

[16] O'Riordan C, Savage E, Murphy J, O'Donovan S, Doherty C, Cusack C, McCaffrey N. Cardiovascular disease risk factor profile of experienced male amateur marathon runners: a systematic review. Sports Health 2023;15:661-72. https://doi.org/10.1177/19417381221142511.

[17] Marti B, Abelin T, Minder CE, Vaterlaus JP. Smoking, alcohol consumption, and endurance capacity: an analysis of 6,500 19-year-old conscripts and 4,100 joggers. Prev Med 1988;17:79-92. https://doi.org/10.1016/0091-7435(88)90074-6.

[18] De Nitto S, Stefanizzi P, Gesualdo L, De Giglio O, Montagna MT, Caggiano G, Tafuri S. Prevalence of cigarette smoking: a cross-sectional survey between individual and team sport athletes. Ann Ig 2020;32:132-40. https://doi.org/10.7416/ai.2020.2338.

[19] Zuckerman SL, Tang AR, Richard KE, Masters AK, Kuhn AW, Bonfield CM, Yengo-Kahn AM. The behavioral, psychological, and social impacts of team sports: a systematic review and meta-analysis. Phys Sportsmed 2021;49:246-61. https://doi.org/10.1080/00913847.2020.1818277.

[20] Mattila VM, Raisamo S, Pihlajamäki H, Mäntysaari M, Rimpelä A. Sports activity and the use of cigarettes and snus among young males in Finland in 1999–2010. BMC Public Health 2012;12:230. https://doi.org/10.1186/1471-2458-12-230.

[21] Mittal S, Komiyama M, Ozaki Y, Miyashita M, Ozaki M, Sato T, Akazawa H, Komuro I. Impact of smoking initiation age on nicotine dependency and cardiovascular risk factors: a retrospective cohort study in Japan. Eur Heart J Open 2023;4:oead135. https://doi.org/10.1093/ehjopen/oead135.

[22] Olsen IG, Garritsen HH, Bentsen P, Christensen JH, Larsen BT, Overgaard K, Ringgaard S, Sørensen M, Tønnesen P. Adolescents' beliefs, attitudes, and social norms with regard to smoking and sports: a qualitative study. BMJ Open 2021;11:e046613. https://doi.org/10.1136/bmjopen-2020-046613.

[23] Melnick MJ, Miller KE, Sabo DF, Farrell MP, Barnes GM. Tobacco use among high school athletes and nonathletes: results of the 1997 Youth Risk Behavior Survey. Adolescence 2001;36:727-47.

[24] Feigenbaum E, Di Nitto DM, Croff JM. Gender differences in tobacco use among U.S. Special Olympics athletes. Disabil Health J 2018;11:466-70. https://doi.org/10.1016/j.dhjo.2017.10.010.

[25] Šaranović SĐ, Vićić J, Pešić I, Pešić M, Micić S, Đurić B, Vujović N. The influence of tobacco use on pulmonary function in elite athletes. Int J Environ Res Public Health 2019;16:3515. https://doi.org/10.3390/ijerph16193515.

[26] D'Ascenzi F, Caselli S, Alvino F, Digiacomo V, Lemme E, Radini G, Corrado D, Pelliccia A, Henein MY, Mondillo S. Cardiovascular risk profile in Olympic athletes: an unexpected and underestimated risk scenario. Br J Sports Med 2019;53:37-42. https://doi.org/10.1136/bjsports-2018-099530.

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HEALTH PROMOTION

Anthropometric Status, Lifestyle Habits, and Foot Posture Findings among Primary Schoolchildren in Mostar, Bosnia and Herzegovina: A Regional Cross-Sectional Study

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Keywords

Children • BMI-for-age • Waist circumference • Dietary habits • Screen time • Physical activity • Foot posture • School health

Summary

Introduction. *Childhood lifestyle habits and anthropometric status are markers of future cardiometabolic and musculoskeletal risk, but regional data from Bosnia and Herzegovina are limited. This study examined associations of excess body weight and waist circumference with lifestyle habits and foot posture findings among fifth- and seventh-grade schoolchildren from the Mostar region.*
Methods. *This cross-sectional study included 404 pupils attending routine school health examinations at the Mostar Health Center between September 2024 and May 2025. Data were collected using a structured questionnaire and standardized anthropometry. Nutritional status was classified according to WHO BMI-for-age criteria. Multivariable regression models assessed factors associated with excess body weight, waist circumference, and foot posture abnormalities.*
Results. *Excess body weight was present in 113 of 401 children (28.2%). Screen time ≥3 h/day was not associated with excess body weight (OR=0.71; 95% CI: 0.39-1.29; p=0.261) or waist circumference (B=-0.89; 95% CI: -3.01 to 1.24; p=0.413). Daily breakfast consumption was associated with lower odds of excess body weight (OR=0.42; 95% CI: 0.26-0.69; p=0.001), as was female sex (OR=0.45; 95% CI: 0.27-0.73; p=0.002). Fruit consumption was not significant (p=0.052). Foot posture abnormalities were associated with low physical activity and urban residence, but not with excess body weight or waist circumference.*
Conclusions. *Excess body weight was common. Breakfast consumption showed the most consistent favorable association with anthropometric status, while foot posture findings were related to physical activity and residence. These findings support school health strategies addressing nutrition and movement-related behaviors.*

Introduction

Childhood lifestyle habits are important determinants of later cardiometabolic health. Physical inactivity, excessive recreational screen time, and suboptimal dietary patterns may begin early in life and persist into adolescence and adulthood. This is clinically relevant because school age is a sensitive period for the development of daily routines related to movement, eating, and sedentary behavior. Data from the World Health Organization (WHO) European Childhood Obesity Surveillance Initiative (COSI) show substantial levels of insufficient physical activity and excessive screen time among children aged 6-9 years across European countries [1]. These patterns support the need to monitor lifestyle habits before adverse anthropometric and cardiometabolic consequences become established.
Anthropometric assessment is a central component of child health surveillance. Body mass index-for-age is widely used to classify nutritional status in school-aged children, while waist circumference provides additional information on central adiposity [2]. These indicators are not interchangeable because BMI reflects relative body mass, whereas waist circumference better captures abdominal fat distribution. This distinction is clinically relevant because childhood overweight and obesity are associated with cardiometabolic risk factors, including insulin resistance, dyslipidemia, elevated blood pressure, and later obesity-related morbidity [3]. Therefore, studies that examine both BMI-for-age categories and waist circumference can provide a more complete picture of anthropometric risk in children.
Children's lifestyle habits are shaped by family, socioeconomic, and environmental conditions. Dietary routines, physical activity, outdoor play, and screen exposure do not depend only on individual choice. They are also influenced by parental routines, household resources, neighborhood safety, traffic exposure, and access to spaces that support active play. Recent systematic reviews show that children and adolescents

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from lower socioeconomic backgrounds are more likely to have unfavorable health behaviors, including poorer diet quality, lower physical activity, and greater sedentary behavior [4, 5]. Built-environment features may further reinforce these inequalities by shaping children's daily opportunities for movement and healthy routines. These findings indicate that anthropometric risk should be interpreted together with the behavioral and environmental context in which children live.

Place-specific monitoring is needed to translate behavioral and environmental risks into practical prevention. Schools and school health services are particularly suitable for this purpose because they reach large numbers of children during a critical developmental period. Routine school health examinations allow standardized monitoring of growth, weight status, lifestyle habits, and selected clinical findings. COSI has demonstrated the value of standardized school-based monitoring of childhood obesity and related behaviors across countries [6]. Recent surveillance literature also emphasizes that better monitoring of physical activity and sedentary behavior can directly inform public health priorities and intervention planning [7]. In settings where national surveillance data are limited, school health services can provide important regional evidence for targeted prevention.

Evidence on lifestyle habits and anthropometric status among schoolchildren in Bosnia and Herzegovina remains limited. Recent standardized evidence from Bosnia and Herzegovina includes a pilot implementation of the COSI methodology in the Republic of Srpska, which examined overweight and obesity among primary-school children using standardized procedures [8]. Evidence from neighboring Croatia has also shown insufficient physical activity and unfavorable movement-related behaviors among children and adolescents [9]. However, few studies from Bosnia and Herzegovina have jointly examined BMI-for-age status, waist circumference, dietary habits, recreational screen time, physical activity, outdoor play and foot posture abnormalities in primary school children. This gap limits the ability to design locally relevant school health interventions.

Foot posture abnormalities may represent an additional clinical marker in routine child health assessment. Excess body weight can increase mechanical loading on the feet, while low physical activity may contribute to poorer musculoskeletal function and altered foot posture. Recent studies and reviews suggest that pediatric flatfoot is associated with elevated BMI, insufficient physical activity, and urban residence, although diagnostic criteria and measurement approaches vary across studies [10, 11]. Foot posture findings are therefore relevant in school health examinations because anthropometric and musculoskeletal screening often occur during the same preventive visit. Examining foot posture together with BMI-for-age, waist circumference, and lifestyle habits may broaden the understanding of child health beyond weight status alone.

To address this gap, this study examined anthropometric status, lifestyle habits, and foot posture abnormalities among fifth- and seventh-grade schoolchildren from the Mostar region. The primary aim was to examine the distribution of BMI-for-age categories and to assess whether excess body weight was associated with recreational screen time, physical activity, outdoor play, dietary habits, sex, grade, and urban/rural residence. Secondary aims were to analyze waist circumference as a continuous anthropometric outcome and to assess whether excess body weight and waist circumference were associated with foot posture abnormalities. By combining anthropometric, behavioral, environmental, and clinical foot data, this study provides regional evidence from routine school health examinations in Bosnia and Herzegovina.

Materials and Methods

Study Design and Setting

This regional cross-sectional study examined anthropometric status, lifestyle habits, and foot posture findings among fifth- and seventh-grade primary schoolchildren from the Mostar region, Bosnia and Herzegovina. The study was conducted between September 2024 and May 2025 at the Mostar Health Center, which provides primary healthcare services for the City of Mostar and surrounding settlements.

The study was embedded within routine systematic school health examinations conducted as part of the preventive school health program in primary care. These examinations include anthropometric assessment and evaluation of lifestyle-related health factors. Because participation was linked to routine preventive examinations rather than illness-related visits, the sample may be regarded as a regional school-based sample rather than a clinical sample. However, it should not be interpreted as nationally representative.

Participants

The sampling frame consisted of fifth- and seventh-grade pupils scheduled for routine systematic school health examinations during the study period. Participants were recruited consecutively during these examinations. All pupils attending the examination and meeting the eligibility criteria were invited to participate.

The inclusion criteria were: (1) attendance in the fifth or seventh grade of primary school; (2) scheduled attendance for a routine systematic school health examination during the study period; (3) residence in the Mostar Health Center catchment area; and (4) written informed consent provided by a parent or legal guardian. The exclusion criteria were: (1) absence from the scheduled examination; (2) lack of parental or legal guardian consent; and (3) incomplete key questionnaire or anthropometric data for analyses in which those variables were required.

During the study period, 413 pupils were scheduled for examination. Nine pupils were absent because of acute

illness and did not attend the scheduled visit. The final study sample comprised 404 pupils.

Sample size calculation

The minimum required sample size was calculated using the single-population proportion formula for cross-sectional studies: $n=Z^2p(1-p)/d^2$. Assuming a 95% confidence level, a 5% margin of error, and an expected proportion of 50% for the most conservative estimate, the minimum sample size was 384 pupils. After allowing for possible non-attendance and incomplete data, the target sample was increased to approximately 404 pupils. A total of 413 pupils were scheduled, and 404 were included in the final sample.

Before analysis, participants were classified according to grade level (fifth *vs*. seventh grade) and place of residence (urban *vs*. rural). Place of residence was classified administratively according to the registered home address of each pupil. Urban residence was defined as residence within the administrative boundaries of the City of Mostar, characterized by higher population density and developed urban infrastructure. Rural residence included surrounding villages and settlements outside the urban administrative area, characterized by lower population density and predominantly rural land use.

Questionnaire and Lifestyle Variables

Data were collected using a structured questionnaire administered during routine school health examinations. The questionnaire was adapted from established child health surveillance items, including items used in the World Health Organization Childhood Obesity Surveillance Initiative.

Sociodemographic variables included age, sex, grade, and place of residence. Dietary variables included meal frequency, breakfast consumption, snacking, and frequency of intake of selected food groups and beverages. Movement-related variables included recreational screen time, physical activity outside school, and time spent in outdoor play.

The questionnaire was piloted in 30 pupils to assess clarity, comprehension, and completion time. Although the questionnaire was adapted from established surveillance instruments, it was not formally validated as an independent standalone instrument in the primary school population of Bosnia and Herzegovina. Therefore, self-reported behavioral data should be interpreted with appropriate caution.

For analysis, selected lifestyle variables were dichotomized to identify less favorable behavioral patterns and to ensure adequate group sizes for multivariable modeling. Recreational screen time was recorded as less than 1 hour/day, 1-3 hours/day, 3-5 hours/day, or more than 5 hours/day, and was dichotomized as <3 hours/day versus ≥3 hours/day. Physical activity outside school was recorded as less than 1 hour/day, 1-2 hours/day, or more than 2 hours/day, and low physical activity was defined as <1 hour/day. Outdoor play was analyzed as <1 hour/day versus ≥1 hour/day.

Dietary variables were analyzed using clinically interpretable categories. Daily breakfast consumption was defined as eating breakfast every day. Daily fruit consumption, daily vegetable consumption, and daily sweets consumption were defined according to reported daily intake. Frequent fast-food intake was defined as consumption several times per week or more. Carbonated drink consumption was analyzed as a binary variable based on reported intake.

Anthropometric Measurements and Nutritional Status

Anthropometric measurements were obtained according to standardized procedures for children and adolescents. Body weight was measured using a calibrated digital scale (Seca 803, Seca GmbH & Co. KG, Hamburg, Germany), and body height was measured using a portable stadiometer (Seca 213, Seca GmbH & Co. KG, Hamburg, Germany). Waist circumference was measured using a standard anthropometric technique. All measurements were performed during the same examination visit by trained healthcare personnel with experience in anthropometric assessment.

Body mass index was calculated as weight in kilograms divided by height in meters squared. Nutritional status was classified using age- and sex-specific World Health Organization BMI-for-age growth reference criteria for children and adolescents aged 5-19 years. Thinness was defined as BMI-for-age z-score <-2 SD, normal weight as BMI-for-age z-score ≥-2 SD and ≤+1 SD, overweight as BMI-for-age z-score >+1 SD and ≤+2 SD, and obesity as BMI-for-age z-score >+2 SD.

For regression analyses, overweight and obesity were combined into a single outcome variable, defined as excess body weight. Children with thinness and normal weight were used as the reference group. Waist circumference was analyzed as a continuous anthropometric outcome because locally validated waist circumference cut-off values were not available for this study population.

Foot Posture Assessment

Foot posture was assessed as part of routine clinical screening during school health examinations. Initial inspection was performed by trained family medicine/school health physicians, and children with clinically relevant suspected abnormalities were referred for orthopedic evaluation and further management. For analysis, foot posture was dichotomized as no clinically relevant abnormality versus positive clinical foot posture finding. Because the study was conducted within routine school health assessments, foot posture findings were interpreted as clinical screening findings rather than instrument-based biomechanical measurements.

Study Procedure

Data collection was conducted during routine systematic school health examinations at the Mostar Health Center. Questionnaire data were obtained through physician-led interviews using the structured questionnaire.

Additional clarification was provided when necessary to improve comprehension and response accuracy. When needed, parents or legal guardians assisted in clarifying behavioral responses.

Questionnaire data were coded and de-identified before statistical analysis. Anthropometric measurements and foot posture assessments were obtained during the same examination visit. All data were analyzed in anonymized form.

The study was conducted in accordance with institutional and national ethical standards and with the Declaration of Helsinki and its later amendments. Ethical approval was obtained from the Ethics Committee of the Mostar Health Center (Approval No. 705-37-247/24). Written informed consent was obtained from all parents or legal guardians before participation.

Outcomes

The primary outcome was excess body weight, defined as overweight or obesity according to WHO BMI-for-age criteria. This outcome was selected because the revised analysis focused on anthropometric status and its association with lifestyle habits.

Secondary outcomes were waist circumference and foot posture abnormality. Waist circumference was analyzed as a continuous anthropometric measure. Foot posture abnormality was analyzed as a binary clinical outcome.

The main explanatory variables were recreational screen time, physical activity outside school, outdoor play, dietary habits, sex, grade, and urban/rural residence. Urban/rural residence and sex were analyzed both as descriptive variables and as covariates in multivariable models.

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics, version 20.0 (SPSS Inc., Chicago, IL, USA). The distribution of continuous variables was assessed using the Kolmogorov-Smirnov test and inspection of descriptive distributional parameters. Continuous variables are presented as mean ± standard deviation or median and interquartile range, as appropriate. Categorical variables are presented as frequencies and percentages.

Between-group comparisons were performed according to variable type and analytical purpose. Continuous variables were compared using the independent-samples t test or one-way analysis of variance when comparing more than two groups. Non-parametric alternatives were considered when distributional assumptions were not met. Categorical variables were compared using the chi-square test or Fisher's exact test when expected cell counts were small.

BMI-for-age categories were compared across lifestyle, dietary, and foot posture variables. For multivariable analysis, excess body weight was modeled as a binary outcome. Multivariable logistic regression was used to examine factors associated with excess body weight. The model included recreational screen time ≥3 hours/day, low physical activity outside school, outdoor play <1 hour/day, daily breakfast consumption, daily sweets consumption, frequent fast-food intake, daily fruit consumption, daily vegetable consumption, carbonated drink consumption, sex, grade, and urban/rural residence. Results are presented as odds ratios with 95% confidence intervals.

Waist circumference was analyzed as a continuous outcome using multivariable linear regression. The explanatory variables were the same as those used in the excess body weight model. Results are presented as unstandardized regression coefficients with 95% confidence intervals. This model was used to examine whether lifestyle and dietary variables were associated with waist circumference independently of sex, grade, and place of residence.

Two separate multivariable logistic regression models were fitted to examine factors associated with foot posture abnormality. Model 5A included excess body weight as the main anthropometric predictor, while Model 5B included waist circumference as the main anthropometric predictor. Both models were adjusted for low physical activity, sex, grade, and urban/rural residence. The two anthropometric indicators were not entered simultaneously. Results are presented as odds ratios with 95% confidence intervals.

Complete-case analysis was used for each statistical model, including only participants with complete data for all variables entered into that model. Denominators are therefore reported where relevant. A two-sided p value of less than 0.05 was considered statistically significant.

Results

Participant characteristics

A total of 404 fifth- and seventh-grade primary school pupils were included in the study. Of the total sample, 193 were boys (47.5%) and 211 were girls (52.5%). A total of 176 pupils (43.6%) attended the fifth grade, while 228 pupils (56.4%) attended the seventh grade. According to place of residence, 269 pupils (66.6%) lived in an urban area and 135 pupils (33.4%) in a rural area.

The mean body weight was 45.55±11.21 kg, the mean body height was 154.09±10.22 cm, the mean waist circumference was 64.63±8.92 cm, and the mean BMI was 18.96±3.59 kg/m² among participants with valid BMI data. The WHO BMI-for-age z-score could be calculated for 401 children. Three records were excluded from BMI-for-age z-score analysis because of invalid or missing age or anthropometric data; all three excluded records were from girls.

Boys had significantly higher waist circumference and BMI-for-age z-scores than girls, whereas body weight, body height, and BMI values did not differ significantly by sex (Tab. I).

BMI-for-age categories and lifestyle habits

According to WHO BMI-for-age classification, thinness

Tab. I. Baseline characteristics of participants by sex.

Variable	Total	Boys	Girls	*p*
Number of participants, n (%)	404 (100.0)	193 (47.5)	211 (52.5)	–
Age, years	11.30±1.08	11.25±1.09	11.35±1.06	0.383
Body weight, kg	45.55±11.21	45.78±11.58	45.34±10.88	0.699
Body height, cm	154.09±10.22	153.80±11.20	154.36±9.25	0.587
Waist circumference, cm	64.63±8.92	66.14±9.12	63.24±8.53	0.001
BMI, kg/m²	18.96±3.59	19.17±3.48	18.77±3.69	0.256
BMI-for-age z-score	0.29±1.29	0.46±1.40	0.14±1.18	0.014
Excess body weight, n (%)	113/401 (28.2)	67/193 (34.7)	46/208 (22.1)	0.007

Values are presented as mean ± standard deviation or n (%). BMI=body mass index. Excess body weight was defined as overweight or obesity according to WHO BMI-for-age criteria. ***p values*** refer to comparisons between boys and girls.

Tab. II. Lifestyle habits and foot posture findings according to BMI-for-age categories.

Variable	Thinness	Normal weight	Overweight	Obesity	*p*
Number of children, n (%)	14 (3.5)	274 (68.3)	70 (17.5)	43 (10.7)	—
Waist circumference, cm	56.07±3.38	61.22±5.26	70.79±7.46	80.46±9.21	<0.001
BMI-for-age z-score	-2.89±1.14	-0.18±0.74	1.47±0.26	2.41±0.33	<0.001
Screen time ≥3 h/day, n (%)	2/14 (14.3)	70/271 (25.8)	16/66 (24.2)	8/42 (19.0)	0.631
Physical activity <1 h/day, n (%)	0/14 (0.0)	44/270 (16.3)	13/66 (19.7)	12/43 (27.9)	0.083
Outdoor play <1 h/day, n (%)	1/14 (7.1)	22/270 (8.1)	7/66 (10.6)	4/43 (9.3)	0.926
Daily breakfast, n (%)	8/13 (61.5)	151/267 (56.6)	25/65 (38.5)	16/42 (38.1)	0.013
Daily fruit consumption, n (%)	5/14 (35.7)	132/270 (48.9)	26/69 (37.7)	14/43 (32.6)	0.097
Daily vegetable consumption, n (%)	3/14 (21.4)	44/270 (16.3)	9/69 (13.0)	6/43 (14.0)	0.828
Daily sweets consumption, n (%)	5/14 (35.7)	120/270 (44.4)	34/69 (49.3)	19/43 (44.2)	0.791
Fast food ≥several times/week, n (%)	4/14 (28.6)	47/270 (17.4)	18/69 (26.1)	5/43 (11.6)	0.165
Carbonated drinks, n (%)	4/14 (28.6)	71/274 (25.9)	14/70 (20.0)	9/43 (20.9)	0.686
Foot posture abnormality, n (%)	1/14 (7.1)	43/270 (15.9)	11/70 (15.7)	11/42 (26.2)	0.283

Values are presented as mean±standard deviation or n (%). BMI=body mass index. *p* values refer to comparisons across BMI-for-age categories.

was identified in 14 children (3.5%), normal weight in 274 children (68.3%), overweight in 70 children (17.5%), and obesity in 43 children (10.7%). Overweight and obesity combined, defined as excess body weight, were present in 113 of 401 children (28.2%).

No statistically significant difference in recreational screen time was observed across BMI-for-age categories. Screen time ≥3 hours/day was reported by 14.3% of children with thinness, 25.8% of children with normal weight, 24.2% of children with overweight, and 19.0% of children with obesity (p=0.631).

Low physical activity (<1 h/day) was numerically more frequent among children with overweight and obesity, particularly among children with obesity; however, this difference was not statistically significant (p=0.083).

Daily breakfast consumption differed significantly across BMI-for-age categories (p=0.013). Children with overweight and obesity were less likely to eat breakfast every day compared with children with normal weight. Other analyzed dietary variables did not differ significantly across BMI-for-age categories (Tab. II).

Association of lifestyle habits with excess body weight

In multivariable logistic regression, screen time ≥3 h/day was not independently associated with excess body weight. Low physical activity and outdoor play <1 h/day were also not significantly associated with excess body weight after adjustment.

Among the analyzed dietary variables, daily breakfast consumption was independently associated with lower odds of excess body weight after adjustment for screen time, physical activity, outdoor play, dietary variables, sex, grade, and place of residence (OR=0.42; 95% CI: 0.26–0.69; p=0.001).

Daily fruit consumption was not significantly associated with excess body weight after adjustment (OR=0.61; 95% CI: 0.37-1.00; p=0.052). Daily sweets consumption, frequent fast-food intake, daily vegetable consumption, and carbonated drink consumption were also not independently associated with excess body weight. Girls had significantly lower odds of excess body weight compared with boys (Tab. III).

Waist circumference as a continuous anthropometric outcome

Waist circumference was analyzed as a continuous anthropometric measure. In the multivariable linear regression model, screen time ≥3 h/day was not independently associated with waist circumference. Low physical activity and outdoor play <1 h/day were also not significantly associated with waist circumference.

Daily breakfast consumption was not significantly associated with waist circumference after adjustment

Tab. III. Multivariable logistic regression for excess body weight.

Predictor	OR	95% CI	*p*
Screen time ≥3 h/day	0.71	0.39-1.29	0.261
Physical activity <1 h/day	1.57	0.84-2.94	0.157
Outdoor play <1 h/day	1.03	0.43-2.45	0.952
Daily breakfast	0.42	0.26-0.69	0.001
Daily sweets consumption	1.41	0.86-2.30	0.174
Fast food ≥several times/week	0.97	0.50-1.87	0.930
Daily fruit consumption	0.61	0.37-1.00	0.052
Daily vegetable consumption	0.83	0.42-1.64	0.596
Carbonated drinks	0.57	0.31-1.05	0.073
Girls *vs.* boys	0.45	0.27-0.73	0.002
7th *vs.* 5th grade	0.83	0.50-1.36	0.461
Urban *vs.* rural residence	1.11	0.66-1.88	0.699

Outcome: excess body weight, defined as overweight or obesity according to WHO BMI-for-age criteria. OR=odds ratio; CI=confidence interval. All listed predictors were entered simultaneously into the model. Complete-case analysis included 379 participants; number of events=104. Model calibration was acceptable (Hosmer-Lemeshow χ^2=11.16; df=8; p=0.193). Model discrimination was modest (AUC=0.684).

Tab. IV. Linear regression for waist circumference.

Predictor	B	95% CI	*p*
Screen time ≥3 h/day	-0.89	-3.01 to 1.24	0.413
Physical activity <1 h/day	0.56	-1.90 to 3.02	0.657
Outdoor play <1 h/day	-0.33	-3.61 to 2.96	0.846
Daily breakfast	-1.78	-3.60 to 0.03	0.054
Daily sweets consumption	1.35	-0.47 to 3.18	0.145
Fast food ≥several times/week	-2.22	-4.63 to 0.19	0.071
Daily fruit consumption	-1.41	-3.24 to 0.42	0.131
Daily vegetable consumption	-1.82	-4.28 to 0.63	0.145
Carbonated drinks	-1.91	-4.07 to 0.25	0.083
Girls *vs.* boys	-3.97	-5.80 to -2.13	<0.001
7th *vs.* 5th grade	3.53	1.67 to 5.39	<0.001
Urban *vs.* rural residence	-0.21	-2.15 to 1.73	0.832

Outcome: waist circumference in centimeters. B=unstandardized regression coefficient; CI=confidence interval. All listed predictors were entered simultaneously into the model. Complete-case analysis included 367 participants. Model fit: R^2=0.117; adjusted R^2=0.087.

(B=-1.78 cm; 95% CI: -3.60 to 0.03; p=0.054). Other dietary variables were not independently associated with waist circumference. Sex and grade were the most stable factors associated with waist circumference: girls had lower waist circumference, whereas seventh-grade pupils had higher waist circumference compared with fifth-grade pupils (Tab. IV).

Foot posture abnormality

Foot posture abnormality was recorded in 67 of 398 children with available data. Foot posture abnormality was slightly more frequent among children with excess body weight than among children without excess body weight, but the difference across BMI-for-age categories was not statistically significant.

Two separate logistic regression models were fitted for foot posture abnormality to avoid simultaneous inclusion of closely related anthropometric indicators. Model 5A included excess body weight as the main anthropometric predictor, while Model 5B included waist circumference as the main anthropometric predictor. Both models were adjusted for low physical activity, sex, grade, and urban/rural residence.

In Model 5A, excess body weight was not independently associated with foot posture abnormality. Low physical activity and urban residence were independently associated with higher odds of foot posture abnormality. In Model 5B, waist circumference was not independently associated with foot posture abnormality. Low physical activity and urban residence remained independently associated with higher odds of foot posture abnormality (Tab. V).

Urban/rural and sex differences

In the additional urban/rural analysis, no significant differences were found between rural and urban children in BMI-for-age categories, excess body weight, BMI, BMI-for-age z-score, or waist circumference. However,

Tab. V. Logistic regression models for foot posture abnormality.

Predictor	Model 5A OR	95% CI	*p*	Model 5B OR	95% CI	*p*
Excess body weight	1.33	0.73-2.40	0.347	-	-	-
Waist circumference	-	-	-	1.02	0.98-1.05	0.316
Physical activity <1 h/day	2.20	1.16-4.18	0.016	2.34	1.23-4.45	0.009
Girls *vs.* boys	0.90	0.52-1.57	0.719	0.96	0.55-1.67	0.875
7th *vs.* 5th grade	1.60	0.91-2.80	0.103	1.53	0.86-2.74	0.149
Urban *vs.* rural residence	2.26	1.17-4.36	0.015	2.25	1.16-4.39	0.017

Outcome: foot posture abnormality.
OR: odds ratio; CI: confidence interval. Model 5A included excess body weight, physical activity <1 h/day, sex, grade, and urban/rural residence. Model 5B included waist circumference, physical activity <1 h/day, sex, grade, and urban/rural residence. The two anthropometric indicators were not entered simultaneously. Model 5A included 388 participants with complete data; number of events =65; Hosmer-Lemeshow χ^2=5.08; df=8; p=0.749; AUC=0.639. Model 5B included 376 participants with complete data; number of events =64; Hosmer-Lemeshow χ^2=5.29; df=8; p=0.726; AUC=0.641.

urban children more frequently had screen time ≥3 h/day compared with rural children (28.8% *vs*. 16.8%; p=0.009) and more frequently spent less than 1 h/day in outdoor play (11.0% *vs*. 4.6%; p=0.035). Foot posture abnormality was also more frequent among urban than rural children (19.9% *vs*. 10.7%; p=0.022).

By sex, boys more frequently had excess body weight than girls (34.7% *vs*. 22.1%; p=0.007). The distribution of BMI-for-age categories also differed significantly by sex, with overweight and obesity being more frequent among boys. Screen time ≥3 h/day, low physical activity, and foot posture abnormality did not differ significantly between boys and girls.

Discussion

In this regional cross-sectional study of fifth- and seventh-grade schoolchildren, excess body weight was present in more than one quarter of participants. The main findings were that recreational screen time was not independently associated with excess body weight or waist circumference, whereas daily breakfast consumption was associated with lower odds of excess body weight. Daily fruit consumption showed a similar direction of association but did not reach statistical significance after adjustment. Girls had lower odds of excess body weight than boys. Waist circumference was mainly associated with sex and grade, while foot posture abnormalities were not independently associated with excess body weight or waist circumference. However, low physical activity and urban residence were associated with higher odds of foot posture abnormality. These findings suggest that anthropometric status, lifestyle habits, and clinical foot findings should be interpreted as related but distinct components of school health surveillance.

The observed prevalence of excess body weight confirms that childhood overweight and obesity represent an important regional public health issue [12]. In the present study, 28.2% of children had overweight or obesity according to WHO BMI-for-age criteria. This proportion is clinically relevant because childhood overweight and obesity are associated with later cardiometabolic risk, including insulin resistance, dyslipidemia, elevated blood pressure, and persistence of obesity into adolescence and adulthood [13]. Recent COSI-based work also confirms that standardized school-based monitoring is essential for identifying childhood obesity and related behavioral patterns across countries [6]. Therefore, the present results support the value of routine school health examinations as a practical regional surveillance platform in Bosnia and Herzegovina.

The sex difference in excess body weight deserves particular attention. Boys had higher BMI-for-age z-scores and a higher prevalence of excess body weight than girls, even though BMI values alone did not differ significantly by sex. This supports the importance of using age- and sex-specific BMI-for-age classification rather than interpreting crude BMI values alone in children. Sex differences in childhood obesity are commonly reported across populations, although their direction and magnitude may vary by age, pubertal timing, physical activity, diet, and sociocultural context [14]. In this study, the lower odds of excess body weight among girls remained significant after adjustment for lifestyle variables, grade, and place of residence. This finding indicates that sex should be retained as an important covariate in regional child health analyses.

Recreational screen time was not independently associated with excess body weight in this sample. This finding differs from parts of the broader literature, where higher screen exposure has often been linked to adiposity and less favorable health behaviors in children. However, the absence of an independent association in the present study may reflect several factors. Screen time was self-reported and measured in broad categories, total sedentary time was not objectively measured, and screen exposure may influence body weight through pathways not fully captured here, such as snacking, sleep, parental rules, or total energy intake [15-17]. COSI data show substantial levels of excessive screen time among European children, and screen-based leisure remains a relevant surveillance target [1]. Thus, the present finding should not be interpreted as evidence that screen exposure is irrelevant, but rather that it was not an independent anthropometric correlate in this specific regional dataset after adjustment.

Physical activity showed different patterns depending on

the outcome examined. Low physical activity was not independently associated with excess body weight or waist circumference, but it was associated with higher odds of foot posture abnormality. This supports the view that movement-related behaviors should not be reduced to a single obesity-related indicator. Physical activity may influence musculoskeletal function, postural control, lower-limb strength, and foot loading patterns even when its association with BMI is weak or not statistically significant. Recent surveillance literature emphasizes that physical activity and sedentary behavior should be monitored as distinct but related domains, because each may have different determinants and health consequences [7]. In the present study, low physical activity appeared more relevant to foot posture findings than to anthropometric outcomes.

Daily breakfast consumption was the most consistent dietary correlate of excess body weight in the adjusted model. Children who reported eating breakfast every day had substantially lower odds of excess body weight after adjustment for screen time, physical activity, outdoor play, other dietary variables, sex, grade, and place of residence. This finding is consistent with a recent systematic review and meta-analysis suggesting that breakfast skipping is associated with higher odds of overweight or obesity in children and adolescents [18]. The observed association may reflect broader household routines, better overall diet quality, more regular meal timing, or lower likelihood of compensatory snacking later in the day. Because the study was cross-sectional, this association should not be interpreted causally. Nevertheless, breakfast habits may represent a simple and practical marker for school health counseling.

Daily fruit consumption showed a similar direction of association with excess body weight, but it did not reach statistical significance after adjustment. This result should be interpreted cautiously because fruit intake was self-reported, analyzed as a simplified binary variable, and had a confidence interval close to 1.00. It may reflect a broader pattern of healthier dietary routines rather than an isolated protective effect of fruit intake [19]. In contrast, daily sweets consumption, frequent fast-food intake, daily vegetable consumption, and carbonated drink consumption were not independently associated with excess body weight. These findings may partly reflect measurement limitations, small subgroup sizes, social desirability bias, or residual confounding. The inverse direction observed for frequent fast-food intake in the waist circumference model was not statistically significant and should not be interpreted as protective. It may reflect reporting bias, reverse behavior change among children with higher weight, or residual confounding.

Waist circumference provided information that complemented BMI-for-age classification [20]. Waist circumference increased across BMI-for-age categories and was strongly associated with sex and grade in multivariable analysis. However, screen time, physical activity, outdoor play, and dietary variables were not independently associated with waist circumference after adjustment. The linear regression model explained a limited proportion of the variance in waist circumference, suggesting that important determinants were not captured. These may include pubertal development, parental adiposity, genetic factors, detailed dietary intake, sleep duration, and objectively measured physical activity. Because waist circumference reflects central adiposity more directly than BMI, future studies in this population should consider locally relevant waist circumference references or waist-to-height ratio to improve cardiometabolic risk stratification [20, 21].

Foot posture abnormalities showed a different pattern from anthropometric outcomes. Excess body weight and waist circumference were not independently associated with foot posture abnormality in the present analysis, whereas low physical activity and urban residence were consistently associated with higher odds of abnormal foot posture. This finding partly differs from recent literature suggesting that pediatric flatfoot is often associated with elevated BMI and obesity [22, 23]. Several explanations are possible. First, foot posture in this study was assessed as a clinical screening finding rather than by podoscope, plantar pressure analysis, or a validated foot posture index. Second, the outcome included broader clinical foot posture abnormalities and may not correspond exactly to instrument-defined flatfoot. Third, the number of positive foot findings was modest, limiting statistical power. These differences in case definition and measurement method may explain why BMI and waist circumference were not significant predictors in this sample.

The association between urban residence and foot posture abnormality is clinically interesting but should be interpreted cautiously. Urban residence remained associated with higher odds of foot posture abnormality even after adjustment for physical activity, sex, grade, and anthropometric indicators. Recent pediatric flatfoot research has also reported higher prevalence among urban children and associations with insufficient physical activity, although mechanisms remain uncertain [24]. Possible explanations include differences in habitual movement, footwear patterns, surfaces used for play, access to outdoor activity, or referral and detection patterns during clinical screening [24]. Because these contextual variables were not directly measured, urban residence should be interpreted as a contextual marker rather than a causal factor.

The public health implications of these findings are practical for school health services. Routine school health examinations can identify not only excess body weight, but also behavioral and clinical patterns that may require counseling or follow-up. The results suggest that school health strategies should address regular meal routines, physical activity, and opportunities for active play, while also recognizing that anthropometric and musculoskeletal findings may have different correlates [25, 26]. This is consistent with the broader role of school-based surveillance systems, which provide standardized, repeated, and locally actionable information for child health planning [6, 7]. In Bosnia

and Herzegovina, where standardized regional data remain limited, routine school health services may be an important foundation for future surveillance.

Several limitations should be considered when interpreting these findings. First, the cross-sectional design precludes conclusions about temporal direction or causality. Second, lifestyle and dietary variables were self-reported during physician-led interviews and may be affected by recall bias and social desirability bias. Third, the questionnaire was adapted from established surveillance items but was not formally validated as a standalone instrument in the primary school population of Bosnia and Herzegovina. Fourth, physical activity and screen time were assessed using categorical self-report rather than accelerometry or digital tracking. These limitations may have reduced precision and weakened the ability to detect associations between lifestyle behaviors and anthropometric outcomes.

Additional methodological limitations relate to anthropometric classification, missing data, and model performance. BMI-for-age classification requires accurate age and sex information; three records could not be classified because of invalid or missing age or anthropometric data, and minor misclassification around category thresholds cannot be fully excluded. Missing data were handled using complete-case analysis, which may introduce selection bias if excluded records differed systematically from included records. The logistic regression models showed acceptable calibration but modest discrimination, and the waist circumference model explained a limited proportion of variance. These findings indicate that unmeasured factors, including socioeconomic status, parental BMI, pubertal stage, sleep duration, total energy intake, and objectively measured activity, may be important determinants of child anthropometric status and foot posture.

The foot posture assessment also has specific limitations. Foot posture abnormality was based on clinical screening during routine school health examination rather than instrument-based biomechanical measurement. Therefore, the outcome should be interpreted as a clinical screening finding, not as a definitive diagnosis of flatfoot or another specific structural foot disorder. Differences in examiner judgment and the absence of standardized foot posture indices may have introduced classification variability. Future studies should consider using podoscopic assessment, plantar pressure analysis, or validated foot posture indices to better characterize pediatric foot posture in relation to BMI, waist circumference, and physical activity [10, 11, 24].

Despite these limitations, the study has several strengths. It included a regional school-based sample embedded in routine preventive health care, reducing the likelihood that the sample reflected only children seeking care for illness. The study also combined BMI-for-age categories, waist circumference, dietary habits, screen time, physical activity, outdoor play, and foot posture findings in the same analytical framework. This integrated approach is relevant for primary care and school health practice because it reflects the type of multidimensional assessment that can realistically be performed during routine preventive examinations. The findings therefore provide useful regional evidence for school health planning in the Mostar area and may inform future standardized surveillance efforts in Bosnia and Herzegovina.

Conclusion

In this regional sample of fifth- and seventh-grade schoolchildren, excess body weight was present in more than one quarter of participants. Recreational screen time was not independently associated with excess body weight or waist circumference, whereas daily breakfast consumption was associated with lower odds of excess body weight. Daily fruit consumption showed a similar direction of association but did not reach statistical significance after adjustment. Foot posture abnormalities were not independently associated with excess body weight or waist circumference, but were associated with low physical activity and urban residence. These findings support school health strategies that combine anthropometric monitoring, counseling on regular dietary routines, promotion of physical activity, and clinical screening for musculoskeletal findings during routine preventive examinations.

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

IM contributed to the conception and design of the study, coordination of the research process, organization of data collection, data acquisition, database preparation, statistical analysis, interpretation of results, drafting of the manuscript, and preparation of the final version. MP contributed to data acquisition during routine school health examinations, clinical data verification, interpretation of results, and critical revision of the manuscript. DV contributed to interpretation of clinical and school health findings, verification of clinical terminology, and critical revision of the manuscript for important intellectual content. BO contributed to interpretation of musculoskeletal findings, interpretation of foot posture abnormalities, and critical revision of the manuscript for important intellectual content. MK contributed to interpretation of musculoskeletal and clinical foot posture findings, verification of clinical terminology related to foot posture assessment, and

critical revision of the manuscript for important intellectual content. BP contributed to study design, methodological supervision, interpretation of results, supervision of manuscript structure, and critical revision of the manuscript for important intellectual content. All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

References

[1] Whiting S, Buoncristiano M, Gelius P, Abu-Omar K, Pattison M, Hyska J, Duleva V, Musić Milanović S, Zamrazilová H, Hejgaard T, Rasmussen M, Nurk E, Shengelia L, Kelleher CC, Heinen MM, Spinelli A, Nardone P, Abildina A, Abdrakhmanova S, Aitmurzaeva G, Usuopva Z, Pudule I, Petrauskiene A, Sant'Angelo VF, Kujundzic E, Popovic S, Fismen AS, Bergh IH, Fijalkowska A, Rito AI, Cucu A, Brinduse LA, Peterkova V, Gualtieri A, García-Solano M, Gutiérrez-González E, Abdurrahmonova Z, Boymatova K, Yardim N, Tanrygulyyeva M, Weghuber D, Schindler K, Stojisavljević D, Filipović Hadžiomeragić A, Markidou Ionnaidu E, Ahrens W, Hassapidou M, Kovacs VA, Ostojic SM, Ticha L, Starc G, Russell Jonsson K, Spiroski I, Rutter H, Mendes R, Williams J, Rakovac I, Breda J. Physical Activity, Screen Time, and Sleep Duration of Children Aged 6-9 Years in 25 Countries: An Analysis within the WHO European Childhood Obesity Surveillance Initiative (COSI) 2015-2017. Obes Facts 2021;14:32-44. https://doi.org/10.1159/000511263.

[2] De Onis M. Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ 2007;85:660-7. https://doi.org/10.2471/BLT.07.043497.

[3] Valerio G, Di Bonito P, Calcaterra V, Cherubini V, Corica D, De Sanctis L, Di Sessa A, Faienza MF, Fornari E, Iughetti L, Licenziati MR, Manco M, Del Giudice EM, Morandi A, Salerno M, Street ME, Umano GR, Wasniewska M, Maffeis C. Cardiometabolic risk in children and adolescents with obesity: a position paper of the Italian Society for Pediatric Endocrinology and Diabetology. Ital J Pediatr 2024;50:205. https://doi.org/10.1186/s13052-024-01767-x.

[4] Gautam N, Dessie G, Rahman MM, Khanam R. Socioeconomic status and health behavior in children and adolescents: a systematic literature review. Front Public Health. 2023;11:1228632. https://doi.org/10.3389/fpubh.2023.1228632.

[5] Ziegeldorf A, Schoene D, Fatum A, Brauer K, Wulff H. Associations of family socioeconomic indicators and physical activity of primary school-aged children: a systematic review. BMC Public Health 2024;24:2247. https://doi.org/10.1186/s12889-024-19174-6.

[6] Breda J, McColl K, Buoncristiano M, Williams J, Abdrakhmanova S, Abdurrahmonova Z, Ahrens W, Akhmedova D, Bakacs M, Boer JMA, Boymatova K, Brinduse LA, Cucu A, Duleva V, Endevelt R, Sant'Angelo VF, Fijałkowska A, Hadžiomeragić AF, García-Solano M, Grøholt EK, Gualtieri A, Hassapidou M, Hejgaard T, Hyska J, Kelleher CC, Kujundžić E, Mäki P, Markidou Ioannidou E, Melkumova M, Moyersoen I, Milanović SM, Nurk E, Ostojic SM, Peterkova V, Petrauskienė A, Pudule I, Rito AI, Russell Jonsson K, Rutter H, Salanave B, Seyidov N, Shengelia L, Silitrari N, Spinelli A, Spiroski I, Starc G, Stojisavljević D, Tanrygulyyeva M, Tichá Ľ, Usupova Z, Weghuber D, Yardim N, Zamrazilová H, Zbanatskyi V, Branca F, Weber M, Rakovac I. Methodology and implementation of the WHO European Childhood Obesity Surveillance Initiative (COSI). Obes Rev 2021;22(Suppl 6):e13215. https://doi.org/10.1111/obr.13215.

[7] Reilly J, Aubert S, Brazo-Sayavera J, Liu Y, Cagas J, Tremblay M. Surveillance to improve physical activity of children and adolescents. Bull World Health Org 2022;100:815-24. https://doi.org/10.2471/BLT.22.288569.

[8] Ljubojević A, Sekulić Z, Vučković I, Vukić Z, Pašić G, Marković S, Alexe DI, Kwok N, Perić R. Overweight and obesity prevalence: a pilot implementation of the "COSI" methodology in the Republic of Srpska. Cent Eur J Public Health. 2024;32:71-6. https://doi.org/10.21101/cejph.a8219.

[9] Pedišić Ž, Strika M, Matolić T, Sorić M, Šalaj S, Dujić I, Rakovac M, Radičević B, Podnar H, Greblo Jurakić Z, Jerković M, Radašević H, Čvrljak J, Petračić T, Musić Milanović S, Lang Morović M, Krtalić S, Milić M, Papić A, Momčinović N, Mišigoj-Duraković M, Heimer S, Jurakić D. Physical Activity of Children and Adolescents in Croatia: A Global Matrix 4.0 Systematic Review of Its Prevalence and Associated Personal, Social, Environmental, and Policy Factors. J Phys Act Health 2023;20:487-99. https://doi.org/10.1123/jpah.2022-0500.

[10] Xu L, Gu H, Zhang Y, Sun T, Yu J. Risk Factors of Flatfoot in Children: A Systematic Review and Meta-Analysis. IJERPH. 202219:8247. https://doi.org/10.3390/ijerph19148247.

[11] Giuca G, Marletta DA, Zampogna B, Sanzarello I, Nanni M, Leonetti D. Correlation Between the Severity of Flatfoot and Risk Factors in Children and Adolescents: A Systematic Review. Osteology 2025;5:11. https://doi.org/10.3390/osteology5020011.

[12] Zhang X, Liu J, Ni Y, Yi C, Fang Y, Ning Q, Shen B, Zhang K, Liu Y, Yang L, Li K, Liu Y, Huang R, Li Z. Global Prevalence of Overweight and Obesity in Children and Adolescents: A Systematic Review and Meta-Analysis. JAMA Pediatr 2024;178:800-13. https://doi.org/10.1001/jamapediatrics.2024.1576.

[13] Chung ST, Krenek A, Magge SN. Childhood Obesity and Cardiovascular Disease Risk. Curr Atheroscler Rep 2023;25:405-15. https://doi.org/10.1007/s11883-023-01111-4.

[14] Shah B, Tombeau Cost K, Fuller A, Birken CS, Anderson LN. Sex and gender differences in childhood obesity: contributing to the research agenda. BMJNPH 2020;3:387-90. https://doi.org/10.1136/bmjnph-2020-000074.

[15] Haghjoo P, Siri G, Soleimani E, Farhangi MA, Alesaeidi S. Screen time increases overweight and obesity risk among adolescents: a systematic review and dose-response meta-analysis. BMC Prim Care 2022;23:161. https://doi.org/10.1186/s12875-022-01761-4.

[16] Ghasemirad M, Ketabi L, Fayyazishishavan E, Hojati A, Maleki ZH, Gerami MH, Moradzadeh M, Fernandez JHO, Akhavan-Sigari R. The association between screen use and central obesity among children and adolescents: a systematic review and meta-analysis. J Health Popul Nutr 2023;42:51. https://doi.org/10.1186/s41043-023-00391-5.

[17] Fang K, Mu M, Liu K, He Y. Screen time and childhood overweight/obesity: A systematic review and meta-analysis. Child 2019;45:744-53. https://doi.org/10.1111/cch.12701.

[18] Wang K, Niu Y, Lu Z, Duo B, Effah CY, Guan L. The effect of breakfast on childhood obesity: a systematic review and meta-analysis. Front Nutr 2023;10:1222536. https://doi.org/10.3389/fnut.2023.1222536.

[19] Larruy-García A, Mahmood L, Miguel-Berges ML, Masip G, Seral-Cortés M, De Miguel-Etayo P, et al. Diet Quality Scores, Obesity and Metabolic Syndrome in Children and Adolescents: A Systematic Review and Meta-Analysis. Curr Obes Rep 2024;13:755-88. https://doi.org/10.1007/s13679-024-00589-6.

[20] Arellano-Ruiz P, García-Hermoso A, García-Prieto JC, Sánchez-López M, Martínez Vizcaíno V, Solera-Martínez M. Predictive Ability of Waist Circumference and Waist-to-Height Ratio for Cardiometabolic Risk Screening among Spanish Children. Nutrients 2020;12:415. https://doi.org/10.3390/nu12020415.

[21] Muñoz-Hernando J, Escribano J, Ferré N, Closa-Monasterolo R, Grote V, Koletzko B, Gruszfeld D, ReDionigi A, Verduci E, Xhonneux A, Luque V. Usefulness of the waist-to-height ratio for predicting cardiometabolic risk in children and its suggested boundary values. Clin Nutr 2022;41:508-16. https://doi.org/10.1016/j.clnu.2021.12.008.

[22] Calcaterra V, Marin L, Vandoni M, Rossi V, Pirazzi A, Grazi R, Patané P, Silvestro GS, Carnevale Pellino V, Albanese I, Fa-

biano V, Febbi M, Silvestri D, Zuccotti G. Childhood Obesity and Incorrect Body Posture: Impact on Physical Activity and the Therapeutic Role of Exercise. Int J Environ Res Public Health 2022;19:16728. https://doi.org/10.3390/ijerph192416728.

[23] Kardm SM, Alanazi ZA, Aldugman TAS, Reddy RS, Gautam AP. Prevalence and functional impact of flexible flatfoot in school-aged children: a cross-sectional clinical and postural assessment. J Orthop Surg Res 2025;20:783. https://doi.org/10.1186/s13018-025-06207-y.

[24] Bahir AW, Bahir MA, Kartheepan K, Bahir Q, Xuewen G, Shao G, Jiayu X, Ying X. Prevalence and modifiable risk factors for pediatric flatfoot among schoolchildren in Kunming and Kandahar: a cross-sectional study. Front Pediatr 2026;13:1739543. https://doi.org/10.3389/fped.2025.1739543.

[25] Hassan MA, McDonough DJ, Ryu S, Zhou W, Oginni J, Gao Z. Comparative effectiveness of school-based obesity prevention programs for children and adolescents: a systematic review and network meta-analysis. Front Public Health 2024;12:1504279. https://doi.org/10.3389/fpubh.2024.1504279.

[26] Nikooyeh B, Yari Z, Hariri Z, Baghdadi G, Yazdani H, Motlagh ME, Neyestani TR. Which school-based interventions work better to combat obesity in children? A network meta-analysis. Syst Rev 2025;14:125. https://doi.org/10.1186/s13643-025-02871-7.

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Nosocomial infection

Dirty Soap? The Overlooked Risk in Hospital Hygiene

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Keywords

Antiseptics • Antimicrobial • Hand Hygiene • Intrinsic Contamination • Soap

Dear Editor,
Handwashing with soap and water is a well-established and effective measure for reducing the transmission of potentially pathogenic microorganisms [1]. According to the CDC's *Guideline for Hand Hygiene in Health-Care Settings*, washing with plain or antibacterial soap is preferred over alcohol-based hand rubs when hands are visibly soiled, contaminated with proteinaceous material, blood, or other body fluids, after toilet use, or following contact with patients suspected or confirmed to have *Clostridioides difficile* [2].
Plain soaps are detergents that lack antimicrobial agents, although they may contain preservatives, whereas antimicrobial soaps incorporate specific antiseptic compounds. Notably, all types of soap, including those with antimicrobial properties, may become contaminated with bacteria, thereby posing a recognized risk to health, particularly in healthcare settings [3]. A 2023 systematic review on bacterial contamination of antiseptics (AS), disinfectants (DI), and hand hygiene (HH) products reported that since 1977, in healthcare settings in low- and middle-income countries, liquid soap accounted for 31% (4/13) of documented outbreaks and 18.4% (12/65) of contaminated products identified across 25 cross-sectional studies [4]. Comparable analyses from high-income countries over the past 70 years identified soap contamination in 16% (11/68) of outbreaks and 39% (13/33) of cross-sectional surveys [5].
Gram-negative bacteria represent the principal contaminants of soap, comprising more than 90% of reported isolates. Within this group, non-fermentative species predominate, particularly *Pseudomonas aeruginosa* and *Burkholderia cepacia*, while *Acinetobacter baumannii*, *Chryseobacterium indologenes*, and *Achromobacter xylosoxidans* are less frequently identified. Among the Enterobacterales, *Klebsiella oxytoca* and *Serratia marcescens* are most commonly reported, followed by *Enterobacter cloacae*, *Escherichia coli*, and *Citrobacter freundii*. In contrast, Gram-positive organisms are infrequently implicated (<10%), with Gram-positive bacilli predominating, followed by coagulase-negative staphylococci and *Staphylococcus aureus* [4-6]. Yeast contamination, while exceedingly rare compared with bacterial contamination, has been reported only in soap, with no evidence in other hand hygiene products or disinfectants [4]. A plausible explanation is the limited antifungal efficacy of quaternary ammonium compounds (QUATs), commonly used in antimicrobial soaps, against *Candida* spp., including *Candida auris* [7].
In literature common risks factors associated with soap contamination were related to bacterial characteristics, preparation, containers, and handling practices. These included natural resistance of bacteria (*Burkholderia cepacia*, *Pseudomonas aeruginosa* are intrinsically resistant to QUATs, chlorhexidine), use of non-sterile or contaminated water, incorrect dilution, and preparation in unsuitable environments. Issues related to Container and dispenser involved reuse or improper reprocessing, and biofilm formation. Risky practices mainly included topping up of containers and extended use beyond expiry [4, 5]. The contamination of soap can be either intrinsic; present at the time of manufacture or extrinsic, arising during handling, storage or in use [5].
In March 2026, we incidentally identified intrinsic contamination of *Enterobacter cloacae* in liquid antibacterial soap available in our hospital as part of an outbreak investigation in neonatal ICU due to another micro-organism. No healthcare-associated infections or outbreaks due to *E. cloacae* was reported during that period. Immediate administrative and operational measures were implemented to mitigate risk, and the manufacturer was notified to initiate the product recall.
Leveraging this finding, the following recommendations for hand soap use in the healthcare settings are proposed to guide stakeholders from purchase to protection, ensuring soap quality to reduce infection risks.

A. Selection of soap

1. Liquid soaps are preferred over bar soaps in healthcare settings, as bar soaps have 4-to-20-fold higher propensity to get contaminated in comparison to liquid formulation. Notably, high-income countries have phased out the use of bar soaps in hospitals since the 1980s [8].
2. The selection of antimicrobial over plain soap is not specified in either WHO or CDC guidelines; however, few earlier studies have indicated that antimicrobial soaps may be more effective than plain soap [1, 2, 9, 10]. However, while selecting antimicrobial soaps, it is essential to ensure that they

contain effective concentrations of antiseptic agents. According to WHO, appropriate concentrations are: 0.5-4% chlorhexidine, 0.5-4% chloroxylenol, 0.5-10% iodophors, 0.1-2% triclosan, and QUATs (0.5-0.55% benzalkonium chloride, 0.5-2% cetrimide) [1]. Notably, triclosan has been banned by the US FDA since 2016 due to safety and efficacy concerns [11].
3. It is suggested to procure ready-to-use soap solutions rather concentrated form and then diluting in house. Dilution of liquid soap at any level is strongly discouraged as over dilution leads to decreased efficacy and also contamination from non-sterile tap water is a frequent factor resulting in extrinsic contamination [12].

B. Procurement of the product

1. To minimize the risk of intrinsic contamination, soaps should be sourced from area-specific, reputable manufacturers with stringent quality control, avoiding products from informal markets where water and raw materials may be chemically or microbiologically uncontrolled [13].
2. Apart from legal licenses, under regulatory compliance, following certificate or document should be verified by the manufacturer [5].
    a. Good Manufacturing Practices (GMP) certificate under ISO 22716 an international standard for cosmetics, provides guidelines for production, control, storage and shipment.
    b. European norm (EN) 1499, a standard that specifies the requirements and test method for the hygienic handwash efficacy of handwashing products, including soaps.
    c. United States Pharmacopeia (USP) 1072 which provides structured guidance on how to select, validate, and implement disinfectants and antiseptics in pharmaceutical manufacturing, by the manufacturer related to product integrity.

Additionally, manufacturers can be asked to provide microbiological testing reports issued by an accredited laboratory, certifying the sterility of the respective batch.

C. Best practices / recommendations for containers and dispenser use

1. Preferably use original and disposable containers, limit use of reprocessed containers. Containers are bottles or reservoirs for product storage should preferably be disposable and of small volume. Prolonged use of liquid soap products may lead to degradation of preservatives, thereby promoting biofilm formation in the containers. This can facilitate contamination with opportunistic pathogens such as *Pseudomonas aeruginosa*, *Stenotrophomonasmaltophilia.* [4, 5].
2. Dispensers combine a container with a dispensing mechanism (e.g., a wrist-operated pump) used in working area. The best recommended practice is use of disposable dispenser with single use pump system for liquid soap also like alcohol-based hand rubs and refilling is discouraged. However, in resource-limited settings, cost considerations may necessitate the reuse of dispensers after appropriate reprocessing. The dispenser along with the pump should be cleaned and air dried before refilling. And every time date of refilling should be labelled on the dispenser [4, 5].
3. In view of absence of any guidelines on frequency of refilling or "topping up," the healthcare institutions should develop their own policies based on resource availability and the level of risk in different clinical areas. These policies should aim to standardize practices and reduce the risk of contamination.

D. Role of Infection Prevention and Control Committee (IPCC)

1. It is recommended for IPCC to supervise and monitor and quality of soap products throughout their lifecycle – from selection and procurement to storage, use, and disposal. As per Joint Commission and International Standards hospital leadership should approve resources required for the infection prevention and control program which includes AS, DI and HH products used in the hospital before procurement [4, 14].
2. CDC does not recommend microbiological testing of in-use hand hygiene products or soaps as a routine part of surveillance and is only considered during outbreak investigation [2, 5]. Nevertheless, individual institutions may develop and implement context-specific guidelines based on local risk assessments and resource availability.
3. Based on our experience, we initiated the policy on randomly checking a sample of fresh batch for microbiological analysis which is done by using combined method of direct plating method and enrichment broth.
4. It is recommended that the infection control team closely monitor dispensers during routine rounds, paying attention to overuse or visible changes such as turbidity or bulging [4]. While outbreaks may not always occur, contaminated dispensers may lead to sporadic infections especially in high-risk patients whose source of infection might otherwise go unrecognized.

E. Training and sensitization of stakeholders

1. It is recommended that training programs for healthcare workers be expanded to include all stakeholders involved in the procurement, storage, and distribution of hand hygiene products, with emphasis on intrinsic and extrinsic risks of contamination [5].
2. Training should address the misconception that antiseptic products are inherently safe, highlighting their susceptibility to microbial contamination when improperly handled or stored [5].

3. Trainers should be the infection control team (ICT) and training should be tailored as per the stakeholders. Special attention should be paid on training the housekeeping staff on re-processing and refilling of container [15]. Evidence indicates that inadequate IPC training is associated with poor recognition of contamination risks, whereas trained personnel demonstrate significantly greater awareness of such risk factors [15].

Eventually, the identification of intrinsic contamination of antimicrobial soap used in our institute serves as an eye-opener. The incident act as an important wake-up call, highlighting the necessity for continuous vigilance in maintaining quality standards and preventing adverse events such as outbreaks, the suspicion and detection of which are often complex and challenging. It also underscores the active involvement of ICT in filling the gaps in awareness from procurement till end-user practices that can facilitate product contamination.

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Conflict of interest statement

The author have no conflicts of interest to declare.

Authors' contribution

SG: Concept design, data curation, literature search and manuscript writing.

References

[1] World Health Organization, (WHO). WHO Guidelines on Hand Hygiene in Health Care. Available at: https://www.who. int/publications/i/item/9789241597906. Accessed on: 16/05/2026.

[2] Centers for Disease Control and Prevention (CDC). Guideline for Hand Hygiene in Health-Care Settings Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Available online: https://www.cdc.gov/mmwr/indrr_2002. Accessed on: 16/05/2026.

[3] Zapka CA, Campbell EJ, Maxwell SL, Gerba CP, Dolan MJ, Arbogast JW, Macinga DR. Bacterial hand contamination and transfer after use of contaminated bulk-soap-refillable dispensers. Appl Environ Microbiol 2011;77:2898-904. https://doi.org/10.1128/AEM.02632-10.

[4] Lompo P, Agbobli E, Heroes A-S, Van den Poel B, Kühne V, Kpossou CMG, Zida A, Tinto H, Affolabi D, Jacobs J. Bacterial Contamination of Antiseptics, Disinfectants, and Hand Hygiene Products Used in Healthcare Settings in Low- and Middle-Income Countries–A Systematic Review. Hygiene 2023;3:93-124. https://doi.org/10.3390/hygiene3020010.

[5] Lompo P, Heroes A-S, Agbobli E, Kühne V, Tinto H, Affolabi D, Jacobs J. Bacterial Contamination of Antiseptics, Disinfectants and Hand Hygiene Products in Healthcare Facilities in High-Income Countries: A Scoping Review. Hygiene. 2023;3:136-75. https://doi.org/10.3390/hygiene3020012.

[6] Rezan H, Mehmet D. Analysis of nosocomial outbreak caused by contaminated liquid hand soaps: A single-center study. Tork Hij Den Biyol Derg 2019; 76:267-74.

[7] Weber DJ, Sickbert-Bennett EE, Kanamori H, Rutala WA. New and emerging infectious diseases (Ebola, Middle Eastern respiratory syndrome coronavirus, carbapenem-resistant Enterobacteriaceae, Candida auris): Focus on environmental survival and germicide susceptibility. Am J Infect Control 2019;47S:A29-A38. https://doi.org/10.1016/j.ajic.2019.03.004.

[8] European Committee for Standardization. Chemical disinfectants and antiseptics–Application of European Standards for chemical disinfectants and antiseptics. EN 14885:2022. Brussels: CEN; 2022. Available at iTeh Standards: Accessed on: 15/05/2026.

[9] Rotter M. Hand washing and hand disinfection [Chapter 87]. In: Mayhall CG, ed. Hospital epidemiology and infection control. 2nd ed. Philadelphia, PA: Lippincott Williams & Wilkins 1999.

[10] Boyce JM. Scientific basis for handwashing with alcohol and other waterless antiseptic agents. In: Rutala WA, ed. Disinfection, sterilization and antisepsis: principles and practices in healthcare facilities. Washington, DC: Association for Professionals in Infection Control and Epidemiology, Inc, 2001. Available at: https://www.ncbi.nlm.nih.gov/books/NBK144004/?utm_source=chatgpt.com. Accessed on: 14/05/2026.

[11] United States Food and Drug Administration (FDA). Safety and Effectiveness of Consumer Antiseptics; Topical Antimicrobial Drug Products for Over-the-Counter Human Use. U.S. Food Drug Adm. Fed. Regist 2016;81:61106-29. Available at: https://pubmed.ncbi.nlm.nih.gov/27632802/?utm_source=chatgpt.com. Accessed on: 15/04/2026.

[12] Weber DJ, Rutala WA, Sickbert-Bennett EE. Outbreaks associated with contaminated antiseptics and disinfectants. Antimicrob Agents Chemother 2007;51:4217-24. https://doi.org/10.1128/AAC.00138-07. Epub 2007 Oct 1.

[13] Caetano JA, Lima MA, Di Ciero Miranda M, Serufo JC, Ponte PR. Identification of bacterial contamination in liquid soap for hospital use. Rev Esc Enferm USP 2011;45:153-60. Portuguese. https://doi.org/10.1590/s0080-62342011000100021.

[14] Joint Commission International. Joint Commission International accreditation standards for hospitals (8th ed) 2024.

[15] Lompo P, Heroes AS, Ouédraogo K, Okitale P, Wakpo A, Kalema J, Lunguya O, Tinto H, Affolabi D, Sangaré L, Jacobs J. Knowledge, awareness, and risk practices related to bacterial contamination of antiseptics, disinfectants, and hand hygiene products among healthcare workers in sub-saharan Africa: a cross-sectional survey in three tertiary care hospitals (Benin, Burkina Faso, and DR Congo). Antimicrob Resist Infect Control 2024;13:44. https://doi.org/10.1186/s13756-024-01396-3.

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Nursing

The VEIGA Emotional Competence Scale Short Version: A Validation Study of the Italian Version

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Keywords

Veiga Emotional Competence Scale • Validation study • Emotional Competencies • Emotional Intelligence • Nursing Students

Summary

Background. *There is increasing evidence that nurses experience a high degree of emotional stress already as undergraduate students during their clinical placements, especially in their first year. Students who develop emotional competencies improve their coping skills and decrease stress-related negative effects. A European Erasmus+ project developed an educational program on Emotional Intelligence to be incorporated into European nursing curricula for undergraduate nursing students. To evaluate the efficacy of the study, the Veiga Emotional Competence Scale Short Version for nursing students was used.*
Aim. *To adapt and validate the Italian version of the Veiga Emotional Competence Scale Short Version for nursing students.*
Methods. *This was an instrument validation study, performed following the EORTC Quality of Life Group and the COSMIN guidelines for the translation process. The process consisted of four phases: translation, content validation, face validation, and pilot test. Data were collected between May and July 2023.*
Results. *The Italian Version of the Veiga Emotional Competence Scale Short Version proved to have a good level of content validity Scale-Content Validity Index=0.93). A pilot test was conducted with 100 nursing students of different years of course, showing a good level of internal consistency and reliability (Cronbach's alpha=0.852).*
Conclusion. *The validated and adapted instrument was successfully used during the Serious Game for Nursing Students (SG4NS) project in Italy for the evaluations of the study intervention. This instrument could be used to effectively analyse and evaluate nursing students' emotional competencies for future studies in Italy.*

Introduction

Nursing is one of the most stressful professions, as nurses deal with various stressors on a daily basis such as work overload, interprofessional conflicts, shift work, handling deceased patients, corpses, and family support [1]. One way to cope with high levels of job stress is to develop Emotional Competencies (EC) [2]. EC refer to a set of acquired competencies, based on Emotional Intelligence (EI) and include self-control, empathy and conflict management [2]. In nursing, EC and EI are often used interchangeably [3]. Rakhshani et al. [4] reported that under the best conditions mental intelligence determines only 20% of a person's success, and the remaining 80% depends on other factors such as emotional ones [4]. Since nurses are physically and emotionally more exposed compared to other professions, they need to enhance their emotional skills to adapt to the work environment [5]. If nurses do not have adequate skills to control their emotions, they will not be able to maintain their peace of mind when communicating with patients, family members, colleagues and especially in stressful overloaded crisis situations [3, 5, 6]. Instead, emotionally competent nurses can work in harmony with their thoughts and feelings [2-6]. In addition, EI has been shown to help nurses develop therapeutic relationships with patients, their families, and manage stress and consequently are more likely to provide high-quality services [2]. EI has been found to facilitate the emotional well-being of nursing professionals and helps to improve competence in practicing skills that will benefit patients, colleagues, and families, both as professionals and as individuals [2-6]. Therefore, it is important to provide targetedtraining courses right from the start for undergraduate students to develop their emotional skills, even because undergraduate nursing students experience a high degree of emotional stress already during their clinical placements [7] and increase over the years [8]. There is evidence that students who possess high levels of EI have better coping skills and fewer stress-related negative effects [9, 10].
The "Serious Games - Developing Emotional Competence for Nursing Students" (SG4NS) Erasmus+ project aimed to develop an educational program on Emotional Intelligence for undergraduate nursing students to be integrated into European curricula [11]. The project was

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a multi-national quasi experimental study involving five European countries: Portugal, Spain, Malta, Romania, and Italy. The SG4NS project integrated two important dimensions of the active and dynamic teaching-learning process and the development of soft skills, such as EI [11]. To evaluate the effectiveness of the study, the Veiga Emotional Competence Scale Short Version was used. The instrument had already been validated in Portuguese, it's self-report instrument based on 4 EI's dimensions (self-knowledge, self-regulation, empathy, and social skills) [12, 13]. In the SG4NS Project, the study intervention was evaluated using the Veiga Emotional Competence Scale – Short Version [12, 13]. This instrument evaluates emotional competencies and has already been successfully used to evaluate nurses' emotional competencies [12]. The instrument is divided into 5 sections. Each section explores a different aspect of emotional intelligence: self-awareness (1), self-management (2), self-motivation (3), empathy (4), and social management (5). Each section provides a series of statements regarding a particular emotional behaviour, and participants are asked to state how frequently they perform the behaviour reported in the statement. The answers are given on a Likert scale from 1 (never) to 7 (always). The total score is obtained by calculating average of all the mean values f each subscale [12]. The scores of some subscales had to be reversed before calculating the mean score [12]. To administer the questionnaire in the Italian undergraduate nursing student population, it was translated into Italian to make it easier for them to complete and understand.

Methods

Aim

To adapt and validate the Veiga Emotional Competence Scale Short Version in Italian Language for undergraduate nursing students.

Design and instruments

This quali-quantitative descriptive study was conducted to investigate the experiences of undergraduate nursing students who participated in a Virtual Reality game developed for the SG4NS European project.

To validate the Veiga Emotional Competence Scale Short Version, we followed the EORTC Quality of Life Group [14] and the COSMIN [15] guidelines. The validation process included four phases with three different survey: translation, content validation, face validation, and pilot testing. The translation phase is reported in results section.

To validate the content of the instrument, we submitted a survey to a panel of experts, who were invited to rate the relevance of all the items in the questionnaire. Ratings were assigned using a four-point Likert scale, ranging from 1 (not relevant at all) to 4 (highly relevant). Subsequently, we calculated the Content Validity Index (CVI) for each item and for the instrument as a whole. Consistent with recommended thresholds for content validity, we established that each item-CVI (I-CVI) had to obtain a score of at least ≥0.78 to be deemed relevant, while the scale-CVI (S-CVI) had to obtain a score of at least ≥0.90 for the overall instrument validity [16].

For the face validity process, we enrolled a volunteering group of first-year master's degree nursing students to evaluate the questionnaire. A self-reported survey (second survey) composed by 4 main questions was distributed to identify any items perceived as unclear (question 1), inappropriate (question 2), or difficult to understand (question 3), and asking the overall understanding (question 4) in line with expert guidelines [14-16]. Their responses underwent qualitative analysis, focusing on whether all items were perceived as difficult to comprehend, confusing, contained complex language, featured offensive terminology, or required rephrasing. Afterwards, we incorporated all the changes suggested by the students and made the necessary cultural and linguistic adaptations.

To evaluate internal consistency, we conducted a pilot test and calculated Cronbach's alpha (third surey). We asked a convenience sample of nursing students to complete the questionnaire. No EI education was provided for the student involved in the validation study.

Participants

Sample sizes were calculated based on the EORTC Quality of Life Group guidelines [14] and COSMIN guidelines [15]. The participants were selected using convenience sampling throughout phases of this study. For the content validity phase, a group of 5 experts of nursing education and emotional competencies were involved in line with EORTC and COSMIN guidelines [14-15] and Polit et al. [16]. For the face validity phase, we involved 21 first-year undergraduate nursing students from our university. Finally, the pilot test was conducted at our University, which was one of the partners of the Serious Game for Nursing Students (SG4NS) project. For this phase, we enrolled 100 undergraduate nursing students attending any of the three years of the course.

Data collection

Data were collected between May and July 2023. The data across all the validation phases were collected using a Microsoft Forms® link. Nursing students were enrolled in the study directly from our university. Forward and backward translations were performed in May 2023. Content validity and face validity were performed between June and July, and the pilot test in July 2023.

Data analysis

For content and face validity, the data were encoded and analysed utilizing a Microsoft Excel® spreadsheet. The I-CVI was derived from the average relevance score of each item, while the S-CVI was computed by calculating the total average score of the mean scores of all the I-CVIs. Face validity underwent qualitative analysis. Data pertaining to the pilot test were entered into a Microsoft Excel sheet and analysed using Jamovi® software version 2.2.2 [17]. Cronbach's alpha was

calculated to gauge internal consistency and was utilized to assess internal reliability. Data were analyzed using descriptive statistics, including means and standard deviations (SD) to summarize the emotional competence profiles of the participants. To examine the relationships between subscale scores and their correlation with the year of attendance, Pearson's r coefficient was employed [18].

Ethical consideration

In Italy, ethics approval was obtained from the local regional Ethics Committee before starting the study (427/2023 - DB id 13389). Moreover, the European protocol of the study was approved by the Subcomissão de Ética para as Ciências da Vida e da Saùde da Universidade do Minho, which was the Ethics Committee of the partner that coordinated the SG4NS project and this study, with a positive outcome. Both written and verbal consent was obtained from all participants including the authorisation to audiotape their interviews and all participants were informed that results would be published.

Results

Translation

For the translation, we employed the backtranslation method. Two native Italian translators (a nurse and a midwife) with a good level of proficiency in English (both C1 level of English), who were unfamiliar with the study and questionnaire content, independently translated the questionnaire. Discrepancies in translation primarily involved a distinction between literal and colloquial interpretations of the original Italian phrasing. The resulting translations were harmonized with the collaboration of the translators and researchers. During the reconciliation phase, a supervisor chaired the session to facilitate consensus and ensure the selection of the most linguistically appropriate equivalents.The reconciled final version was then back translated into English by a native English translator with an excellent knowledge of the Italian language as required by the guidelines [14-15].

Content and face validity

Content validity was conducted with a expert panel composed by 5 nurses, of which four were female and the mean age was 44.4 (SD 14.28) years. Four members of the expert panel worked in the field of research. Each item score (I-CVI) and the whole scale score (S-CVI) were analysed to obtain the Content Validity Index (CVI). All the scores obtained for the I-CVI are reported in Table 1. We obtained an S-CVI score of 0.93, therefore the scale was identified as relevant to the study and then underwent face validity (Tab. I).

Face validity was performed by involving 21 students from our master's degree program in nursing and midwifery. The mean age of the participants was 33.52 (SD=9.42) years, and the majority were female (76.19%; n=16). The great majority (90.48%; n=19) had working experience in clinical settings. Of these, 52.38% (n=11) had completed a post-graduate course. Generally, they rated the scale positively and none of the items were considered offensive, confusing, or difficult. Moreover, no negative comments were received. The latest version of the Veiga Emotional Competence Scale in Italian language is reported in the supplementary material (Tab. S1).

Finally, to evaluate internal consistency, a pilot test was performed. One hundred of undergraduate nursing students from our university, who had not been involved in the SG4NS project, were enrolled in the pilot test. One participant declined to provide informed consent; consequently, the final analysis was conducted on a sample of N=99 participants. Most of them were female (83.8%, n=83) and the mean age was 24.4 (SD=5.9) years. Most of them, (47.5%; n=47), were first-year students (Tab. II). Cronbach's alpha was calculated for the whole scale (α=0.852) and for each sub-scale (Self-awareness α=0.79; Emotional management α=0.57; Self-motivation α=0.68; Empathy α=0.77; Social Management α= 0.76).

Descriptive data analysis

Regarding the mean values obtained from the descriptive data, 'self-awareness' (mean=4.9; SD=0.99) and 'empathy' (mean=4.9; SD=0.9) were the emotional competencies that were developed most in the undergraduate nursing students (Tab. III). However, the subscale means, and the total mean scores were different across the three years although no significant differences were found (Tab. III). We performed Pearson's r test to check if there was a correlation between the course years and emotional competencies (Tab. IV), but we found that there was no relationship between the students' course years: 'self-awareness' and 'students' course years' (r=-0.02, p=0.84); 'emotional management' and 'students' course years' (r=0.06, p=0.51); 'self-motivation' and 'students' course years' (r=-0.08, p=0.51); 'empathy' and 'students' course years' (r=0.05, p=0.60); 'social management' and 'students' course years' (r=-0.01, p=0.89). However, we did find that there was positive relationship between the subscales. In particular, there was a strong positive relationship between 'self-awareness' and 'emotional management' (r=0.639; p<.001), and between 'self-awareness' and 'self-motivation' (r=0.755; p<.001).

Discussion

We found that the Italian Veiga Emotional Competence Scale had a good level of validity and reliability. Therefore, the instrument can be effectively used to analyse the EI levels also in Italian nursing students. In a study conducted by da Conceição [19], the Veiga Emotional Competence Scale was adapted to nurses, and showed a good level of validity and reliability in the nursing population.

Tab. I. Content Validity Index of the Veiga Emotional Competence Scale.

Item	I-CVI
Self-awareness a) I let myself absorbed by these emotions, which I'm unable to escape, and they end up conditioning my behavior	1
Self-awareness b) I have an exact sense of the kind of feelings that come over me; *e.g.*, if it's anger, fear, contempt… hate, frustration… I can define them	1
Self-awareness c) Once I'm invaded by negative feelings, I can't control them…	1
Self-awareness d) It decreases my reasoning level. I can't concentrate easily…	1
Self-awareness e) My relational behavior changes… I become muted; euphoric, pouting	1
Self-awareness f) I'm mentally held back by these feelings for a long time. This feeling always comes back…	1
Self-awareness g) I'm an unstable type, with various mood swings…	1
Self-awareness h) I'm an unlucky type, with no luck in life…	1
Emotional management a) I did active physical exercise (aerobic). I spent the energy on activity	0.8
Emotional management b) I reasoned. I tried to understand … and identify what led me to anger. I thought better about that situation	1
Emotional management c) I needed to vent… I tend to use objects, people, or situations as the target of my anger, although afterward, I feel uncomfortable with myself.	1
Emotional management d) I live in a state of chronic worry about the fact that caused my anger… and I keep thinking about the words/people/attitudes that caused it	1
Emotional management e) Apparently calm… Intrusive, persistent thoughts that haunt me day and night	1
Emotional management f) I feel relief if I exercise or play sports	0.8
Emotional management g) I feel relief if I eat or drink	1
Self-motivation a) Pessimistic… (whatever I do, it will go wrong)	1
Self-motivation b) Capable of getting out of any trouble!	0.8
Self-motivation c) Quiet in life. I am absolutely absorbed in what I am doing, indifferent to my surroundings	0.8
Self-motivation d) Seemingly calm, I go about doing what I must… ruminating the thoughts that occur to me	1
Self-motivation e) Uninteresting… Self-pity invades me. I end up feeling "down"	1
Self-motivation f) Resentful… I am invaded by contempt and resentment. I cut with the person who rejects me, I feel resentment for that person(s)	0.8
Self-motivation g) Who thinks: It went wrong as a result of a personal defect, I am like that	1
Empathy a) "register"/perceive the feelings of others	1
Empathy b) "Read" non-verbal channels (tone of voice, hand gestures, facial expression, gaze direction, behavioural attitude, position, etc.) empaths	1
Empathy c) Perceive the consonance between the person's words and body attitude	1
Empathy d) Use calmness (but consciously) to listen…I perceive that I feel good listening to people	1
Empathy e) Become receptive to the other person's instability and I trigger an unstable attitude. I get irritated	0.8
Social management a) I can understand how people are feeling	1
Social management b) In my dealings with others, I clearly say what I think, regardless of what opinion they express	1
Social management c) I have mastery over my feelings	1
Social management d) I can capture their feelings and seem to begin to absorb them	1
Social management e) I have an innate sensitivity to recognize what others are feeling	1
Social management f) I sense interaction…I feel physically synchronized with those around me	0.8
S-CVI	0.93

In our study, the levels of self-awareness and empathy were the competencies that were developed most by our students and there were no differences in terms of gender or age. The competence of 'self-awareness' was discovered also in Australian university students where high scores were obtained also for emotional management and empathy [20]. In a study conducted by Deng et al. [21], females showed higher levels of EI and were more emphatic than males. They concluded that in the Chinese culture, males are more inclined to repress their emotions, so they identified the cultural background as a mechanism to either foster or hinder emotional competencies.

Furthermore, the longitudinal analysis of the mean scores indicates a high and stable EC across all different years of course, with no statistically significant differences observed. This stability suggests that core competencies, particularly, may represent a high baseline characteristic of individuals drawn to the nursing profession, rather than a direct result of academic progression related to EC [22]. This phenomenon is not unique to Italy; international literature highlights a similar trend. Aguilar-Ferrándiz et al. [23] reported that nursing students showed improved cognitive empathy after a coaching-based emotional skills intervention, while emotional intelligence also increased; similar but discipline-specific effects were observed in physiotherapy and occupational therapy students. At the same time also Aradilla-Herrero et al. [24] found that traditional nursing education often fails to increase EI scores, as the "hidden curriculum"

Tab. II. Characteristics of pilot test's student (N=99).

Characteristics	n (%)	Mean (SD)
Age		24.4 (5.86)
Sex		
Male	16 (16.2)	
Female	83 (83.8)	
Year of attendance		
First	47 (47.5)	
Second	31 (31.3)	
Third	21 (21.2)	

tends to prioritize clinical-technical proficiency over the development of emotional regulation. It is interesting to note that, although year of study did not influence EI, our Pearson correlation analysis revealed strong internal relationships between the dimensions, particularly between 'self-awareness' and 'emotion management' (r=0.639) and 'self-motivation' (r=0.755). This suggests that students' emotional profiles are internally consistent and robust. From an international perspective, this reinforces the 'Integrated Model of EI' proposed by Goleman, according to which self-awareness is the foundation upon which all other emotional competencies are built [25]. The high correlation found in our study confirms that for Italian students, as well as for their international peers [19-24], the ability to manage emotions is intrinsically linked to their level of self-perception.

However, the lack of significant growth in areas such as 'Social Management' and 'Emotional Management' contrasts with literature suggesting that clinical exposure should theoretically enhance EC as students navigate complex patient interactions [26-28]. A notable limitation of this study is the absence of formal comparisons with normative data or diverse nursing populations using the Veiga scale.

The development of emotional competencies should become a cornerstone of nursing education, since

Tab. III. Mean scores of the Veiga Emotional Competence Scale (N=99).

Year of attendance	Self-awareness mean (SD)	Emotional management mean (SD)	Self-motivation mean (SD)	Empathy mean (SD)	Social Management mean (SD)	Total mean (SD)
First year	5 (1.04)	4.29 (1.08)	4.52 (0.95)	4.91 (1.10)	4.22 (0.97)	4.59 (0.73)
Second year	4.96 (0.89)	4.34 (0.87)	4.5 (0.82)	4.87 (0.89)	4.22 (0.67)	4.58 (0.58)
Third year	4.84 (1.07)	4.46 (0.85)	4.45 (0.87)	5.07 (0.74)	4.19 (0.65)	4.60 (0.58)
p-value	0.848	0.780	0.953	0.660	0.987	0.990

Tab. IV. Correlations between the course years and emotional competencies.

Emotional competencies		Year of attendance	Self-awareness	Emotional management	Self-motivation	Empathy	Social management
Year of course	Pearson's r	-					
	p-value	-					
	95% CI Upper	-					
	95% CI Lower	-					
Self-awareness	Pearson's r	-0.059	-				
	p-value	0.561	-				
	95% CI Upper	0.140	-				
	95% CI Lower	-0.254	-				
Emotional management	Pearson's r	0.066	0.639	-			
	p-value	0.515	<.001	-			
	95% CI Upper	0.260	0.742	-			
	95% CI Lower	-0.133	0.505	-			
Self-motivation	Pearson's r	-0.031	0.755	0.555	-		
	p-value	0.757	<.001	<.001	-		
	95% CI Upper	0.167	0.829	0.678	-		
	95% CI Lower	-0.227	0.656	0.402	-		
Empathy	Pearson's r	0.053	0.140	0.153	0.121	-	
	p-value	0.601	0.167	0.130	0.234	-	
	95% CI Upper	0.248	0.328	0.340	0.311	-	
	95% CI Lower	-0.146	-0.059	-0.046	-0.079	-	
Social management	Pearson's r	-0.013	0.238	0.299	0.220	0.521	-
	p-value	0.898	0.018	0.003	0.028	<.001	-
	95% CI Upper	0.185	0.416	0.468	0.400	0.652	-
	95% CI Lower	-0.210	0.043	0.107	0.024	0.361	-

nurses must learn how to manage their own and others' emotions to deal with the difficult experiences of life, such as suffering, death, anger, and fear [29]. Emotional intelligence and the education of nursing students are closely associated because the challenges of nursing require them to deal with issues such as death, illness, caregiver management, increasing workloads, the pressure given by job timelines, and the failure to follow hierarchies [30]. Currently, nursing students seem to be poorly prepared in terms of emotional competencies, mainly because the teaching content in this area is often scarce or lacking altogether. To concretely develop EI, it is necessary to start with self-reflection, which is instrumental to promote the development of self-awareness.

Limitations

Despite the significance of the results obtained, this study has certain limitations. Firstly, the sample size is small, which may limit the generalisability of the results to the all population of Italian nursing students. To confirm these preliminary findings and ensure greater statistical power, a larger and more diverse multicentre sample would be required. Secondly, due to the strict deadlines imposed by the international research protocol, it was not possible to conduct a test-retest reliability analysis. Thirdly, although the overall scale demonstrated good internal consistency, some subscales showed lower Cronbach's alpha coefficients. This suggests that some dimensions may contain items that are less internally consistent when translated into the Italian context, or that the constructs themselves are perceived with greater variability by participants. Finally, a Confirmatory Factor Analysis (CFA) was not performed. This decision was taken to maintain methodological alignment with the primary validation study, which did not include CFA.

Conclusion

The Italian version of the Veiga Emotional Competence Scale Short Version proved to have a good level of validation and reliability. This instrument could be used to analyse and evaluate nursing students' emotional competencies in Italy. The validated and adapted instrument was successfully used during the Serious Game for Nursing Students (SG4NS) project for the evaluations of the study intervention. Our findings suggest that a significant pedagogical shift is required to move beyond a purely technical-theoretical focus. By adopting a hybrid model that treats EI as a measurable and trainable professional competences, academic institutions can address the 'emotional labor' of nursing more effectively. Indeed, the observed stability of emotional scores across the three-year program highlights that the transition from instinctive empathy to professional emotional regulation is not a spontaneous process. Consequently, this instrument serves as a cornerstone for future research and practice, bridging the gap between a student's EC and the high-performance demands of modern, person-centered healthcare environments.

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None.

Conflicts of interest statement

The authors of this manuscript have no conflict of interest.

Authors' contributions

All authors contributed to the study conception and design. Material preparation and data collection were performed by FN, IC, MC, MB and GC.Data analyses were performed by FN, MC and IC. The first draft of the manuscript was written by FN, MC, GC and GA. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

References

[1] Kiptulon EK, Elmadani M, Limungi G, Simon K, Tóth L, Horvath E, Szőllősi A, Galgalo D, Máté O, Siket A. Transforming nursing work environments: the impact of organizational culture on work-related stress among nurses: a systematic review. BMC Health Serv Res 2024;24:1526. https://doi.org/10.1186/s12913-024-12003-x.

[2] Kawashima T, Ota Y, Aikawa G, Watanabe M, Ashida K, Sakuramoto H. Effectiveness of emotional intelligence training on nurses' and nursing students' emotional intelligence, resilience, stress, and communication skills: a systematic review and meta-analysis. Nurse Educ Today 2025;151:106743. https://doi.org/10.1016/j.nedt.2025.106743.

[3] Napolitano F, Calzolari M, Di Pietro S, Pagnucci N, Zanini M, Catania G, Aleo G, Gomes L, Sasso L, Bagnasco A. Pedagogical strategies to improve emotional competencies in nursing students: A systematic review. Nurse Educ Today 2024;142:106337. https://doi.org/10.1016/j.nedt.2024.106337.

[4] Rakhshani T, Motlagh Z, Beigi V, Rahimkhanli M, Rashki M. The Relationship between Emotional Intelligence and Job Stress among Nurses in Shiraz, Iran. Malays J Med Sci 2018;25:100-9. https://doi.org/10.21315/mjms2018.25.6.10.

[5] Mao L, Huang L, Chen Q. Promoting resilience and lower stress in nurses and improving inpatient experience through emotional intelligence training in China: A randomized controlled trial. Nurse Educ Today 2021;107:105130. https://doi.org/10.1016/j.nedt.2021.105130.

[6] Karimi L, Leggat SG, Bartram T, Afshari L, Sarkeshik S, Verulava T. Emotional intelligence: predictor of employees' wellbeing, quality of patient care, and psychological empowerment. BMC Psychol 2021;9:93. https://doi.org/10.1186/s40359-021-00593-8.

[7] Gurková E, Zeleníková R. Nursing students' perceived stress, coping strategies, health and supervisory approaches in clinical practice: A Slovak and Czech perspective. Nurse Educ Today 2018;65:4-10. https://doi.org/10.1016/j.nedt.2018.02.023.

[8] Bhurtun HD, Turunen H, Estola M, Saaranen T. Changes in stress levels and coping strategies among Finnish nurs-

ing students. Nurse Educ Pract 2021;50:102958. https://doi.org/10.1016/j.nepr.2020.102958.

[9] Salvarani V, Ardenghi S, Rampoldi G, Bani M, Cannata P, Ausili D, Di Mauro S, Strepparava MG. Predictors of psychological distress amongst nursing students: A multicenter cross-sectional study. Nurse Educ Pract 2020;44:102758. https://doi.org/10.1016/j.nepr.2020.102758.

[10] Alconero-Camarero AR, Sarabia-Cobo CM, González-Gómez S, Ibáñez-Rementería I, Lavín-Alconero L, Sarabia-Cobo AB. Nursing students' emotional intelligence, coping styles and learning satisfaction in clinically simulated palliative care scenarios: An observational study. Nurse Educ Today 2018;61:94-100. https://doi.org/10.1016/j.nedt.2017.11.013.

[11] The "Serious Games. Developing Emotional Competence for Nursing Students" project (SG4NS). Available at: http://sg4ns.ese.uminho.pt/. Accessed on 20/12/2023.

[12] Veiga-Branco A. Emotional Competence. Coimbra: Quarteto 2004.

[13] Veiga-Branco A, Antão C, Ribeiro I, Vaz JA, Ferro-Lebres V. Emotional competence profile in a higher education students sample. In lll International Congress of Emotional Intelligence: book of abstracts. Opatija Croatia 2011, pp. 110-10. https://portalold.ipb.pt/index.php/pt/ipb-en/research-and-innovation/publications/posters-and-meeting-abstracts.

[14] Kuliś D, Bottomley A, Velikova G, Greimel E, Koller M, on behalf of the EORTC Quality of Life Group (2017). EORTC Quality of Life Group Translation Procedure. Available at: https://portalold.ipb.pt/index.php/pt/ipb-en/research-and-innovation/publications/posters-and-meeting-abstracts. Accessed on 04/12/2022.

[15] Mokkink LB, Terwee CB, Patrick DL, Alonso J, Stratford PW, Knol DL, Bouter LM, de Vet HC. The COSMIN study reached international consensus on taxonomy, terminology, and definitions of measurement properties for health-related patient-reported outcomes. J Clin Epidemiol 2010;63:737-45. https://doi.org/10.1016/j.jclinepi.2010.02.006.

[16] Polit DF, Beck CT, Owen SV. Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. Res Nurs Health 2007;30:459-67. https://doi.org/10.1002/nur.20199.

[17] Jamovi (2022). Jamovi (Version 2.2.2) [Computer Software]. Available at: https://www.jamovi.org.

[18] Polit DF, Beck CT. Nursing research: Generating and assessing evidence for nursing practice. 11th edn. Lippincott Williams & Wilkins 2021.

[19] da Conceição A, José A, Ribeiro C, Campos S. A inteligência emocional em enfermeiros responsáveis por serviços hospitalares. Referência. Revista de Enfermagem 2012;III:33-42.

[20] Yu ML, Brown T, Hewitt A, Cousland R, Lyons C, Etherington J. Exploring emotional and social competencies in undergraduate students: Perspectives from CALD and non-CALD students. Aust Educ Res 2023;50:601-24. https://doi.org/10.1007/s13384-022-00507-6.

[21] Deng X, Chen S, Li X, Tan C, Li W, Zhong C, Mei R, Ye M. Gender differences in empathy, emotional intelligence and problem-solving ability among nursing students: A cross-sectional study. Nurse Educ Today 2023;120:105649. https://doi.org/10.1016/j.nedt.2022.105649.

[22] Maben J, Latter S, Clark JM. The sustainability of ideals, values and the nursing mandate: evidence from a longitudinal qualitative study. Nurs Inq 2007;14:99-113. https://doi.org/10.1111/j.1440-1800.2007.00357.x.

[23] Aguilar-Ferrándiz ME, Toledano-Moreno S, Casas-Barragán A, Albornoz-Cabello M, Tapia-Haro R, Correa-Rodríguez M. Implementation of a coaching training for enhancing empathy and emotional intelligence skills in health science students: a prospective study. BMC Med Educ 2024;24:76. https://doi.org/10.1186/s12909-024-05076-z.

[24] Aradilla-Herrero A, Tomás-Sábado J, Gómez-Benito J. Associations between emotional intelligence, depression and suicide risk in nursing students. Nurse Educ Today 2014;34:520-5. https://doi.org/10.1016/j.nedt.2013.07.001.

[25] Goleman D. An EI-based theory of performance. In: Cherniss C, Goleman D, eds. The emotionally intelligent workplace: How to select for, measure, and improve emotional intelligence in individuals, groups, and organizations. Jossey-Bass 2001, pp. 27-44.

[26] Nightingale S, Spiby H, Sheen K, Slade P. The impact of emotional intelligence in health care professionals on caring behaviour towards patients in clinical and long-term care settings: Findings from an integrative review. Int J Nurs Stud 2018;80:106-17. https://doi.org/10.1016/j.ijnurstu.2018.01.006.

[27] Por J, Barriball L, Fitzpatrick J, Roberts J. Emotional intelligence: its relationship to stress, coping, well-being and professional performance in nursing students. Nurse Educ Today 2011;31:855-60. https://doi.org/10.1016/j.nedt.2010.12.023.

[28] Sharon D, Grinberg K. Does the level of emotional intelligence affect the degree of success in nursing studies? Nurse Educ Today 2018;64:21-6. https://doi.org/10.1016/j.nedt.2018.01.030.

[29] Ruiz-Aranda D, Extremera N, Pineda-Galán C. Emotional intelligence, life satisfaction and subjective happiness in female student health professionals: the mediating effect of perceived stress. J Psychiatr Ment Health Nurs 2014;21:106-13. https://doi.org/10.1111/jpm.12052. E.

[30] Dugué M, Sirost O, Dosseville F. A literature review of emotional intelligence and nursing education. Nurse Educ Pract 2021;54:103124. https://doi.org/10.1016/j.nepr.2021.103124.

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Supplementary material

Tab. S1. Veiga Emotional Competence Scale (Italian version).

SCALA VEIGA PER LA COMPETENZA EMOZIONALE – VERSIONE BREVE							
Questo questionario è anonimo e confidenziale. Per favore legga ciascuna delle seguenti affermazioni e rispondere segnando il numero corrispondente alla sua opinione utilizzando la scala riportata di seguito:							
1	2	3	4	5	6	7	
Mai	Raramente	Qualche volta	Abitualmente	Frequentemente	Molto frequentemente	Sempre	
1. In una situazione/relazione negativa della mia vita, quando provo emozioni spiacevoli (tristezza, senso di colpa, vergogna, angoscia, rabbia…), "dentro" di me sento che:							
a) Mi lascio assorbire da queste emozioni a cui non riesco a sfuggire e che finiscono per condizionare il mio comportamento.	1	2	3	4	5	6	7
b) Sono perfettamente in grado di riconoscere le emozioni che provo; es. se è rabbia, paura, disprezzo, odio, frustrazione, posso definirle.	1	2	3	4	5	6	7
c) Non riesco a controllarle.	1	2	3	4	5	6	7
d) La mia capacità di ragionamento diminuisce e non riesco a concentrarmi facilmente.	1	2	3	4	5	6	7
e) Cambia il mio comportamento relazionale. Divento silenzioso, euforico, imbronciato.	1	2	3	4	5	6	7
f) Continuo a pensare e rivivere queste emozioni.	1	2	3	4	5	6	7
g) Ho sbalzi d'umore e instabilità emotiva.	1	2	3	4	5	6	7
h) Non ho fortuna nella vita.	1	2	3	4	5	6	7
2. In una situazione/relazione della mia vita personale o professionale che mi provoca rabbia o collera provo:							
a) A rasserenarmi sfogando la mia rabbia con l'esercizio fisico attivo.	1	2	3	4	5	6	7
b) A rasserenarmi ripensando alla situazione per provare a capire e identificare le cause della rabbia.	1	2	3	4	5	6	7
c) A rasserenarmi sfogando la mia rabbia usando come bersagli oggetti, persone o situazioni, anche se dopo non mi sento a mio agio.	1	2	3	4	5	6	7
d) Un costante stato di preoccupazione su ciò che mi ha causato la rabbia e continuo a pensare a parole/ persone/atteggiamenti che l'hanno causata.	1	2	3	4	5	6	7
e) Calma apparente, ma con pensieri intrusivi e persistenti che mi tormentano giorno e notte.	1	2	3	4	5	6	7
f) Sollievo se faccio esercizio o sport.	1	2	3	4	5	6	7
g) Sollievo se mangio o bevo.	1	2	3	4	5	6	7
3. Le emozioni che provo in una situazione di rifiuto (a livello personale, sociale, professionale), mi fanno sentire come una persona:							
a) Pessimista (qualunque cosa farò andrà male).	1	2	3	4	5	6	7
b) Capace di risolvere ogni problema!	1	2	3	4	5	6	7
c) Tranquilla. Sono completamente assorbito/a da quello che sto facendo, indifferente a ciò che mi circonda.	1	2	3	4	5	6	7
d) Apparentemente tranquillo, continuo a fare quello che devo, ma continuo a pensarci	1	2	3	4	5	6	7
e) Poco interessante, l'autocommiserazione mi pervade. Finisco per sentirmi giù di morale.	1	2	3	4	5	6	7
f) Rancorosa, pervasa da disprezzo e risentimento. Taglio i rapporti con la/e persona/e che mi rifiuta/ rifiutano, sento rancore nei confronti di quella/e persona/e.	1	2	3	4	5	6	7
g) Che pensa: "è andata male a causa del mio carattere, io sono fatto/a così.".	1	2	3	4	5	6	7
4. Nelle mie relazioni ed interazioni personali, familiari, intime ho avuto la sensazione di poter:							
a) Comprendere/percepire le emozioni degli altri.	1	2	3	4	5	6	7
b) Riconoscere i canali non verbali (tono della voce, gestualità, espressione facciale, direzione dello sguardo, atteggiamento, posizione).	1	2	3	4	5	6	7

▶

c) Percepire la corrispondenza tra l'espressione verbale di qualcuno e il suo atteggiamento corporeo.	1	2	3	4	5	6	7
d) Usare consapevolmente la calma per ascoltare. Percepisco che mi sento bene quando ascolto le persone.	1	2	3	4	5	6	7
e) Percepire l'instabilità delle altre persone che provocano in me atteggiamento instabile. Mi irrito.	1	2	3	4	5	6	7
5. Nelle mie relazioni personali, sociali, professionali normalmente ho la percezione che:							
a) Riesco a capire come si sentono le persone.	1	2	3	4	5	6	7
b) Dico chiaramente ciò che penso, indipendentemente da ciò che gli altri esprimono.	1	2	3	4	5	6	7
c) Ho padronanza delle mie emozioni.	1	2	3	4	5	6	7
d) Riesco a cogliere le emozioni degli altri e mi sembra di esserne assorbito.	1	2	3	4	5	6	7
e) Ho un'innata sensibilità nel riconoscere che cosa gli altri provano.	1	2	3	4	5	6	7
f) Mi sento emotivamente e fisicamente sincronizzato con quelli intorno a me.	1	2	3	4	5	6	7

HEALTH TECHNOLOGY ASSESSMENT

Cost and cost effectiveness analysis of myomectomy for uterine fibroids in women: a systematic review

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Keywords

Myomectomy • Uterine fibroids • Cost-effectiveness analysis • Health policy • Cost analysis • Systematic review

Summary

Background. *Myomectomy, a fertility-preserving surgical procedure for uterine fibroids the most common benign gynaecological tumours is widely recommended for women desiring future fertility. However, available economic data on myomectomy are limited, methodologically inconsistent, and dispersed across different healthcare systems. This systematic review aimed to evaluate the cost-effectiveness of myomectomy for symptomatic uterine fibroids by synthesizing economic evaluations of various surgical techniques and contexts.*

Methods. *A systematic search was conducted in four databases, Web of Science, Embase, PubMed/MEDLINE, and Scopus for studies published between 1990 and 2025. Eligible studies included full or partial economic evaluations comparing myomectomy to alternative surgical procedures. Study quality was appraised using the Quality of Health Economic Studies (QHES) instrument. To ensure comparability across currencies and years, all costs were standardized to 2024 International Dollars using purchasing power parity (PPP) adjustments.*

Results. *Fourteen studies met inclusion criteria: ten (71.4%) cost analyses and four (28.6%) comprehensive economic evaluations. Most studies (78.6%) originated from the United States. Reported myomectomy costs varied substantially, ranging from $1,469 to $626,197 (2024 International Dollars), reflecting heterogeneity in surgical methods, healthcare settings, and analytical perspectives. Only 35.7% of studies achieved high methodological quality. Economic outcomes were significantly influenced by the analytical time horizon lifetime models generally favoured myomectomy over hysterectomy, while studies with shorter follow-up periods (≤5 years) often concluded the opposite. Robotic-assisted myomectomy was consistently more expensive ($57,283-$66,596) compared with conventional approaches ($28,721-$37,480). Methodological shortcomings included limited time horizons, unclear perspectives in 90% of cost analyses, and inadequate sensitivity or uncertainty analyses in half of the studies.*

Conclusion. *Myomectomy appears to be a cost-effective intervention from a lifetime perspective, particularly for women seeking fertility preservation. However, existing evidence is constrained by poor methodological quality and inconsistency in economic frameworks. Future research should adopt standardized evaluation models incorporating lifetime analytical horizons, clear perspectives, and comprehensive uncertainty assessments to strengthen evidence-based decision-making and ensure equitable access to fertility-preserving surgical care.*

Background

Uterine fibroids, also known as leiomyomas or myomas, are the most common benign tumours of the female reproductive system, originating from smooth muscle cells in the myometrium [1]. Although many women remain asymptomatic, more than 70% of women of reproductive age develop fibroids by age [2, 3]. When symptomatic, they can cause infertility, pelvic pain, menorrhagia, pressure symptoms, and recurrent pregnancy loss – conditions that significantly reduce quality of life and impose clinical and economic burdens worldwide [3, 4].

Treatment depends on factors such as symptom severity, fibroid size and location, patient age, fertility desires, and sociocultural considerations. Options include pharmacological therapies, minimally invasive techniques (*e.g.,* endometrial ablation, uterine artery embolisation, focused ultrasound), and surgical procedures such as myomectomy or hysterectomy [5-7]. Myomectomy remains the preferred uterus-preserving option, particularly for women wishing to maintain fertility or avoid hysterectomy for personal reasons [8].

Modern myomectomy can be performed via open, laparoscopic, hysteroscopic, or robot-assisted approaches, each differing in invasiveness, recovery, complications, and cost [9, 10]. Choosing the optimal approach requires not only clinical but also economic evaluation, especially in resource-limited settings [11].

Health economic analyses – such as cost-effectiveness, cost-utility, and cost-benefit analyses – assess the relationship between clinical outcomes and resource use and are increasingly vital for evidence-based decision-making [12]. Economic studies of myomectomy should

consider factors like QALYs, recurrence, reoperation, fertility outcomes, and total direct and indirect costs.
However, current literature on the economics of myomectomy remains fragmented, methodologically inconsistent, and lacks standardisation. Many studies have short time horizons, unclear perspectives, inadequate sensitivity analyses, and inconsistent cost reporting, limiting cross-study comparability [13-15].
These gaps underscore the need for a comprehensive systematic review to synthesise existing evidence, evaluate methodological quality, and guide future research. This review aims to support clinicians, payers, and policymakers in making informed decisions and advancing health economic evaluations in uterine fibroid management.

Methods

This study was carried out in accordance with the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (CRD420251125403).

Search Strategy

Several electronic databases, including PubMed/MEDLINE, Embase, Scopus, and Web of Science, were searched extensively for relevant literature. Google Scholar was also included as a source. To ensure the maximum retrieval of pertinent studies, the search covered all publications from 1990 to 2025. A combination of Emtree-controlled vocabulary, Medical Subject Headings (MeSH) terms, and free-text keywords pertinent to economic assessments of myomectomy procedures were used in the search strategy.
The following Boolean logic operators were employed in the main search strategy:
(Cost-effectiveness[tiab] OR cost*[tiab] OR (Effectiveness[tiab] AND Cost[tiab]) OR Cost-Benefit[tiab] OR "Cost Benefit"[tiab] OR Cost-Utility[tiab] OR "Cost Utility"[tiab] OR "Economic Evaluation*"[tiab] OR (Evaluation*[tiab] AND Economic[tiab]) OR "Health resource allocation"[tiab] OR "Medical economics"[tiab] OR (Medical[tiab] AND economic[tiab]) OR "Health economics"[tiab] OR Economic*[ti] OR "Decision analysis"[tiab] OR Decision-analytic[tiab] OR "cost analysis"[tiab] OR (Cost[tiab] AND analysis[tiab]) OR "cost comparison" [tiab] OR "Decision analysis"[tiab] OR (Decision[tiab] AND analytic[tiab])) AND ("Uterine Myomectomy"[Mesh] OR Myomectomy[tiab] OR (Myomectomies[tiab] AND Uterine[tiab]) OR (Myomectomy[tiab] AND Uterine[tiab]) OR "Uterine Myomectomies"[tiab] OR Myomectomies[tiab] OR Fibroidectomy[tiab] OR Fibroidectomies[tiab] OR uterine-preserving[tiab]) AND (Leiomyoma[Mesh] OR Leiomyomas[tiab] OR Fibroid*[tiab] OR "Fibroid Tumor*"[tiab] OR (Tumor*[tiab] AND Fibroid[tiab]) OR Fibromyoma*[tiab] OR "Fibroid Uterus"[tiab] OR (Uterus[tiab] AND Fibroid[tiab]) OR (Leiomyoma[tiab] AND Uterine[tiab]) OR (Fibroid*[tiab] AND Uterine[tiab]) OR "Uterine Fibroid*"[tiab] OR (Fibroma*[tiab] AND Uterine[tiab]) OR (Fibromas[tiab] AND Uterine[tiab]) OR "Uterine Fibroma*"[tiab])
Other techniques, such as manual screening of reference lists from included studies and pertinent systematic reviews, forward citation tracking of seminal publications, and consultation with health economics specialists with expertise in gynaecological interventions, were used to increase search sensitivity. Every search was carried out by two separate reviewers to guarantee thorough coverage and methodological rigour.

Inclusion Criteria

Studies were considered eligible for inclusion if they met the requirements listed below: (1) Study Design: original research publications that offer official economic assessments of myomectomy procedures, such as cost, cost-effectiveness, cost-utility, cost-minimization, or cost-benefit analyses; (2) Population: research on adult women (≥18 years old) who have been diagnosed with uterine fibroids that are symptomatic and need surgery; (3) Intervention: Economic analyses of any myomectomy procedure, such as hysteroscopy myomectomy, robotic-assisted laparoscopic myomectomy, open abdominal myomectomy, or laparoscopic myomectomy; (4) Outcomes: Research that presents quantitative economic results, such as incremental cost-effectiveness ratios, quality-adjusted life years, disability-adjusted life years, direct and indirect healthcare costs, or other verified health economic metrics; (5) Publication Characteristics: Full-text accessible, peer-reviewed publications.

Exclusion Criteria

Studies that did not use English, did not include economic evaluation components, were case reports, letters to editors, editorials, conference abstracts, or commentaries, had previously been the subject of systematic reviews or meta-analyses, evaluated only non-surgical fibroid treatments (medical therapy, uterine artery embolisation without surgical comparison), were conducted in laboratories or on animals, or had insufficient methodological detail for quality assessment were all excluded.

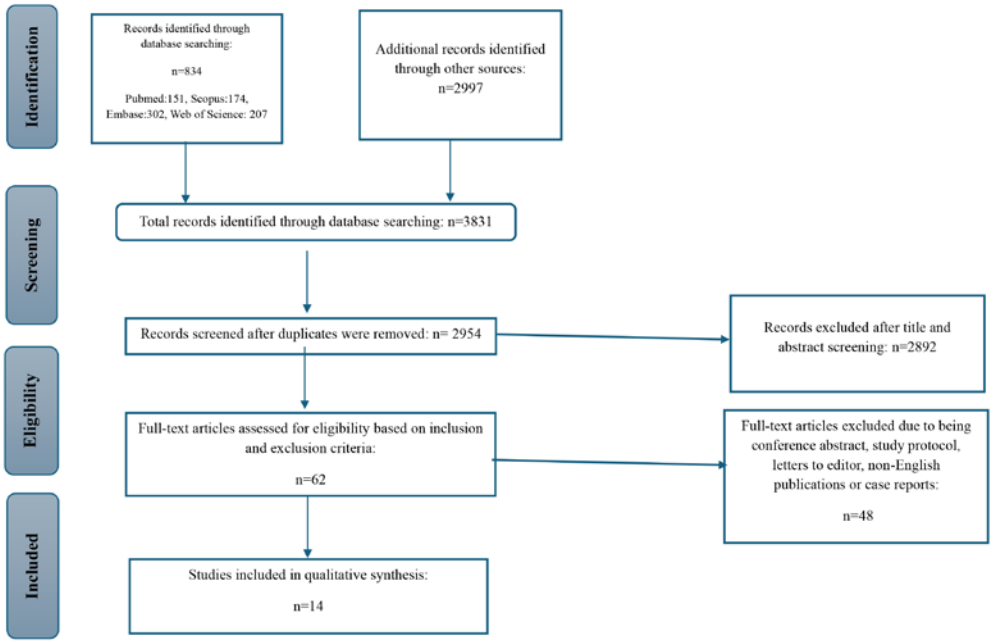
Study Selection Process

All retrieved citations were systematically screened using a standardised method by two independent reviewers (B.D. and A.S.). Potentially relevant publications were first screened by comparing their titles and abstracts to predefined eligibility requirements, and then their full texts were evaluated. Unresolved disagreements were decided by a third senior reviewer (M.B.) who specialised in health economics.

Data Extraction

A thorough, pilot-tested electronic data collection form created especially for cost assessments of surgical procedures was used to extract data (16). Through pilot

Fig. 1. PRISMA Flowchart of Study Selection Process.



testing on three randomly chosen studies, the extraction tool was improved to guarantee data capture reliability, completeness, and clarity.

Data from all included studies was independently extracted by two reviewers (B.D. and A.S.); any discrepancies were found and discussed. By having a third reviewer independently verify 25% of the extractions, quality assurance was preserved. The following domains were covered by the extracted data: (1) Study characteristics: first author, year of publication, nation of origin, study design, data sources, sample size, clinical features, patient demographics, length of follow-up, and funding sources; (2) Intervention Specifics: Comparator interventions, surgical approach features, clinical effectiveness results, safety parameters, and specific myomectomy techniques assessed; (3) Economic Methodology: type of economic analysis, analytical viewpoint (payer, healthcare system, societal), time horizon, discount rates used, modelling techniques, and uncertainty management techniques ; (4) Economic Outcomes: Quality-adjusted life years, willingness-to-pay thresholds, incremental cost-effectiveness ratios, sensitivity analysis results, and detailed cost components (direct medical costs, direct non-medical costs, and indirect costs).

All monetary values were standardized using the protocol outlined by Shemilt et al. [17] in order to facilitate meaningful comparison across studies carried out in various nations and time periods. This methodical technique included: (1) Identification of Original Currency: Base year and original currency documentation for all cost data reported in each study; (2) Inflation Adjustment: Using country-specific Consumer Price Indices from the International Monetary Fund and national statistical offices, historical costs are converted to 2024 values; (3) Currency Conversion: Inflationary costs are translated to US dollars using annual average exchange rates from the International Monetary Fund's International Financial Statistics database; (4) Purchasing Power Parity Adjustment: Using purchasing power parity conversion factors from the databases of the World Bank and Organisation for Economic Co-operation and Development, the final conversion is made to international dollars [18, 19].

With original study periods ranging from 1997 to 2024, this thorough approach made it easier to compare studies from various healthcare systems, such as those in the US, Canada, EU nations, and Asian healthcare markets.

Quality Assessment

Two reviewers independently evaluated the included studies' methodological quality using instruments that were appropriate for the study design and had been validated. Utilising the Quality of Health Economic Studies (QHES) checklist, a comprehensive 16-item tool that assesses study design, data collection techniques, analytical approaches, and reporting quality, full economic evaluations were evaluated. A modified version of the QHES instrument specially designed for cost estimation studies was used to assess cost analysis studies. Criteria from accepted guidelines for cost-of-illness research were also added [20, 21].

High quality (≥75%), moderate quality (50-74%), and low quality (<50%) were the three categories used

to determine quality scores, which were expressed as percentages of the highest possible scores. The interpretation of study results was guided by quality assessments, which also helped to synthesise the evidence overall.

Data Synthesis

The quantitative meta-analysis was neither appropriate nor practical due to the significant heterogeneity in study methodologies, analytical perspectives, patient populations, healthcare settings, and outcome measures. Rather, an organized narrative synthesis was carried out in accordance with accepted frameworks for combining the evidence from economic evaluations [22, 23]. The synthesis method encompassed multiple analytical aspects: (1) Geographic Analysis: To find system-related cost variations, the findings are stratified by healthcare system characteristics and nation-specific economic contexts; (2) Technique-Based Comparison: To find patterns of relative cost-effectiveness, economists systematically compare the economic results of various myomectomy techniques (open, laparoscopic, robotic-assisted, and hysteroscopy); (3) Temporal Analysis: Analysing economic outcome trends from 2002 to 2025 in order to analyse how relative cost-effectiveness has changed over time; (4) Quality-Stratified Analysis: Interpretation of results based on study quality ratings to evaluate the soundness of economic conclusions.

In order to facilitate cross-study comparison, the results are displayed in structured summary tables that include methodological features, incremental cost-effectiveness ratios, and thorough cost breakdowns.

To evaluate the reliability of economic conclusions, sensitivity analyses carried out in primary studies were methodically recorded and combined. Primary studies used deterministic one-way and multi-way sensitivity analyses, Monte Carlo simulation for probabilistic sensitivity analysis, and scenario analyses to look at different assumptions about important parameters.

Myomectomy technique (conventional open versus minimally invasive approaches); healthcare system context (single-payer versus multi-payer insurance systems); study methodology (empirical versus model-based analyses); analytical perspective (healthcare payer versus societal perspective); and time horizon (short-term perioperative costs versus long-term healthcare utilization) were all examined through subgroup analyses. According to Van Hout et al., a web-based adjustment methodology was used for all quantitative analyses, including currency conversions and inflation adjustments (17). This strategy makes use of globally accepted economic indicators, particularly GDP deflators and purchasing power parity (PPP) indices, which are obtained from reliable databases like the World Bank and the Organization for Economic Co-operation and Development (OECD). These indices were used to improve the comparability and validity of economic assessments by methodically standardizing cost data from different currencies and price years to a common target currency and price year. This approach minimizes bias related to manual adjustments, promotes reproducibility, and guarantees methodological transparency. In addition, all data extraction templates, analytical procedures, and supplemental materials are made available to qualified researchers upon reasonable request in order to advance the ideals of open science.

Results

The initial identification phase identified 834 articles from databases such as PubMed (151 articles), Scopus (174 articles), Embase (302 articles), and Web of Science (207 articles) in accordance with the systematic study selection process that adheres to PRISMA guidelines. Additionally, 2,997 articles were identified from other sources (Google Scholar, etc.), for a total of 3,831 articles. 2,954 articles remained for initial screening after 877 duplicate articles were eliminated.

2,892 articles were eliminated during the screening stage on the basis of abstract and title screening. 48 of the 62 articles that were left to be evaluated in full text were disqualified for a variety of reasons, such as case reports, letters to the editor, conference abstracts, non-English studies, and study protocols. Finally, the qualitative synthesis included

Classification and Distribution of Selected Studies

Ten studies (71.4%) carried out pure cost analyses, while four studies (28.6%) of the 14 studies that were ultimately chosen were comprehensive economic evaluations that included cost-effectiveness or cost-utility analyses. In terms of geographic distribution, one study (7.1%) was carried out in Canada, one study (7.1%) in Hong Kong, eleven studies (78.6%) in the United States, and one study (7.1%) in France. Furthermore, a single multi-country study encompassing England, France, and Germany was carried out (Tab. I).

The standardized QHES (Quality of Health Economic Studies) tool was used to evaluate four comprehensive economic evaluation studies. With a score of 98.5 out of 100, the study by You et al. [24] showed the best methodological quality. This study performed exceptionally well across all major criteria, including transparency of the economic model (8 points), selection of reliable data sources (7.5 points), uncertainty analysis (9 points), and clear objective presentation (7 points).

The study by Boyer De Latour et al. [25] came in third with 89 points, while the study by Behera et al. [26] came in second with 94 points. Due mainly to flaws in the data abstraction methodology (3 out of 5) and an insufficiently thorough literature search (5 out of 8 points), the study by Thao et al. [27] received the lowest quality score of 76 points.

Assessment of Cost Analysis Studies

The QHES-Modified tool was used to assess ten cost analysis studies. For clearly, precisely, and quantifiably presenting study objectives, all studies (100%) received

Tab. I. QHES- Modified (Quality of Health Economic Studies - Modified) for Cost Analysis Studies.

Number	Item	Al-Fozan. et al. (2002)	J. Goldberg. et al. (2007)	C.J. Dembek. et al. (2007)	A.P. Advincula. et al. (2007)	G.S .Carls. et al. (2008)	Fernandez et al. (2009)	K. Nash. et al. (2011)	A. Harrington. et al. (2020)	E. Brooks. et al. (2020)	J. Cronan. et al. (2020)
1	Was the study objective presented in a clear, specific, and measurable manner?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	Were the perspective of the analysis (societal, third-party payer etc.) stated? Were the reasons for the perspective selection stated?	No	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially	Partially
3	If estimates came from a subgroup analysis, were the groups prespecified at the beginning of the study?	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
4	Was uncertainty handled by statistical analyses to address random events and sensitivity analysis to cover a range of assumptions?	No	Partially	No	No	Yes	Yes	No	Partially	Yes	Yes
5	Was incremental analysis performed between alternatives for resources and costs?	No	Yes	No	No	Partially	No	Partially	No	Partially	Partially
6	Did the analytic horizon allow time for all relevant and important outcomes? Were benefits and costs that went beyond 1 year discounted (3% to 5%) and justification given for the discount rate?	No	No	Partially	No	No	No	No	No	Partially	No
7	Was the measurement of costs appropriate and the methodology for the estimation of quantities and unit costs clearly described?	Partially	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8	Did the author(s) explicitly discuss direction and magnitude of potential biases?	No	No	Partially	Partially	Partially	No	Partially	Partially	Partially	Partially
9	Were the conclusions/ recommendations of the study justified and based on the study results?	Yes	Yes	Yes	Yes	Yes	Partially	Yes	Yes	Yes	Yes
10	Was there a statement disclosing the source of funding for the study?	No	Partially	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

full scores [13-15, 28-34]. However, nine studies (90%) only partially met this criterion, and only one study (7%) fully specified the analytical perspective.

Three studies (30%) carried out full uncertainty analysis, two studies (20%) carried out partial analysis, and five studies (50%) carried out no uncertainty analysis at all. Additionally, just two studies (20%) carried out incremental analysis between treatment alternatives in its entirety, four studies (40%) did so in part, and four studies (40%) did not provide incremental analysis at all (Tab. II).

Study Design and Type of Economic Evaluation

Two studies [24, 27] used Markov models, one study [26] used a decision model, and one study [25] used a multicenter interventional study design out of the four comprehensive economic evaluation studies. In terms of the kind of economic evaluation, cost-effectiveness analysis was used in two studies [25, 27], cost-utility analysis was used in one study [24], and cost-minimization analysis was used in one study [26].

Tab. II. QHES (Quality of Health Economic Studies).

Number	Item	Points	J.H.S. You. et al. (2009)	M.A. Behera. et al. (2012)	V. Thao. et al. (2023)	A.B. De Latour. et al. (2025)
1	Was the study objective presented in a clear, specific, and measurable manner?	**7**	7	7	7	7
2	Were the perspective of the analysis (societal, third-party payer etc.) stated? Were the reasons for the perspective selection stated?	**4**	4	3	4	3
3	Were cost and health variable estimates used in the analysis from the best available source (i.e., randomized control trial – best, expert opinion – worst)?	**8**	7.5	5	7	8
4	If estimates came from a subgroup analysis, were the groups prespecified at the beginning of the study?	**1**	0.5	0	1	1
5	Was uncertainty handled by statistical analyses to address random events and sensitivity analysis to cover a range of assumptions?	**9**	9	9	9	9
6	Was incremental analysis performed between alternatives for resources and costs?	**6**	6	4	6	6
7	Was the methodology for data abstraction (including the value of health states and other benefits) stated?	**5**	5	3	4	3
8	Did the analytic horizon allow time for all relevant and important outcomes? Were benefits and costs that went beyond 1 year discounted (3% to 5%) and justification given for the discount rate?	**7**	7	5	7	5
9	Was the measurement of costs appropriate and the methodology for the estimation of quantities and unit costs clearly described?	**8**	8	7	7	8
10	Were the primary outcome measure(s) for the economic evaluation clearly stated and did they include the major short-term, long-term, and negative outcomes?	**6**	6	4	5	4
11	Were health outcomes measures/scales valid and reliable? If previously tested valid and reliable measures were not available, was justification given for the measures/scales used?	**7**	7	3	6	7
12	Were the economic model (including structure), study methods and analysis, and the components of the numerator and denominator displayed in a clear, transparent manner?	**8**	8	7	8	8
13	Were the choice of economic model, main assumptions, and limitations of the study stated and justified?	**7**	7	6	7	5
14	Did the author(s) explicitly discuss direction and magnitude of potential biases?	**6**	5.5	4	5	4
15	Were the conclusions/recommendations of the study justified and based on the study results?	**8**	8	6	8	8
16	Was there a statement disclosing the source of funding for the study?	**3**	3	3	3	3
Total points		**100**	**98.5**	**76**	**94**	**89**

Analytical Perspective and Time Horizon

Three (75%) of the studies were from the perspective of the healthcare system (25-27), and one (25%) was from the perspective of society [24]. Studies ranged in duration from one month after surgery (25) to lifetime [27]. Behera et al.'s study examined a brief pre- and post-operative period, while You et al.'s study examined a five-year time horizon as well.

Sample Size and Study Population

Boyer De Latour et al. used a study with 99 patients, while Thao et al., used a model with 10,000 simulated patients. Whereas the study by Behera et al. examined roughly 1,000 patients from secondary data sources (Tab. III), the study by You et al. employed model-based analysis of a hypothetical symptomatic fibroid population [24].

Economic Outcomes and Cost-Effectiveness Analysis

Purchasing Power Adjustment and Currency Standardization

To facilitate valid comparison, all expenses reported in the studies were converted to 2024 international dollars using purchasing power parity (PPP) indices. This analysis revealed that the cost of a myomectomy varied by study country, costing year, and surgical technique, ranging from $1,469 to $626,197 in international dollars.

Cost Analysis of Different Myomectomy Methods

The study by Behera et al. showed that the least expensive surgical procedure is abdominal myomectomy (AM), which costs $7,008 in international dollars (26). Robot-assisted myomectomy (RAM), which cost $10,361 dollars, was the most expensive procedure, while laparoscopic myomectomy (LM), which cost $8,828 dollars, was ranked as intermediate. These results aligned with those of other related studies (Tab. IV).

Cost-Effectiveness Analysis Results

According to Thao et al.'s study, which used a Markov model with a lifetime horizon, the most cost-effective option for women aged 40 and over is a myomectomy with a QALY of 19.38 and a cost of $626,197, as opposed to a hysterectomy with oophorectomy (QALY=19.42, cost=$652,237 dollars) and without oophorectomy (QALY=19.35, cost=$662,192 dollars) (27). According to calculations, myomectomy's incremental cost-effectiveness ratio (ICER) was $726,877 for every extra QALY.

The results of the five-year study by You et al. showed that hysterectomy (QALY=4.368, cost=$2,081 dollars) is more cost-effective than myomectomy (QALY=4.273, cost=$2,234 dollars) and uterine artery embolisation (QALY=4.245, cost=$2,187 dollars) [24]. According to Table IV, the ICER for myomectomy in this study was $1,669 per QALY.

The study by Boyer De Latour et al. demonstrated that although robot-assisted myomectomy was more expensive ($11,445 *vs*. $6,373 for open myomectomy) and had fewer complications, it had an ICER of $221,484 per patient without complications, which is not cost-effective at the €71,000 willingness-to-pay threshold [25].

Results of Cost Analysis Studies

Cost Differences by Geography and Healthcare System

The cost of myomectomy varies greatly by country, type of healthcare system, study year, and surgical technique, according to an analysis of ten cost studies. Germany ($4,322 dollars), France ($1,469-$4,771 dollars), and England ($2,438-$7,941 dollars) have different myomectomy costs, according to a study by Fernandez et al. that was carried out in three European countries (Tab. VI) [33].

Impact of Insurance Type on Treatment Costs

Treatment costs are significantly impacted by the type of insurance, according to a study conducted by Harrington et al. on 113,091 patients [34]. Patients with commercial insurance paid $17,797 for a myomectomy, while those with Medicaid paid $14,727. This 20.8% discrepancy shows how the type of insurance coverage has a big influence on treatment expenses.

Cost Comparison of Different Uterine Fibroid Treatment Methods

According to a study by Brooks et al. that examined 8,548 patients who had undergone myomectomy, the least expensive uterine fibroid treatment method is transcervical fibroid ablation (TFA), which costs $11,406; the most expensive is myomectomy, which costs $29,065; and the most expensive is hysterectomy, which costs $30,815 [29].

The cost of this procedure ($5,716 dollars) is ranked as intermediate when compared to endometrial ablation ($3,583 dollars), hysterectomy ($4,108 dollars), and uterine fibroid embolization ($7,938 dollars), according to a study conducted by Cronan et al. on 11,344 myomectomy patients [31].

Analysis of Direct and Indirect Costs

Carls et al.'s study, which examined 22,860 surgical and 14,214 non-surgical patients, revealed that myomectomy may put less of a financial strain on employers when indirect costs like lost productivity and missed work are taken into account [30]. When compared to other treatment options, which cost $26,807, the unadjusted myomectomy cost $22,701 and the adjusted cost was $28,787. This represents a significant difference.

Comparative Analysis of Myomectomy Surgical Methods

Robotic Myomectomy Compared to Traditional Techniques

The research conducted by Nash et al. on 133 patients

Tab. III. Characteristics and Key Findings of Economic Evaluation Studies.

Study Title	First Author	Publication Year	Country	Costing Year	Sample Size	Intervention
Cost Analysis of Abdominal, Laparoscopic, and Robotic-Assisted Myomectomies	Behera MA	2012	United States	2009 (all costs converted to 2009 USD)	About 1,000 patients (200 with robotic assistance, 300 with laparoscopy, and more than 500 with abdominal myomectomy; secondary data sources)	Abdominal myomectomy (AM), Laparoscopic myomectomy (LM), Robotic-assisted myomectomy (RAM)
Cost-effectiveness of Myomectomy versus Hysterectomy in Women with Uterine Fibroids	Thao V	2023	United States	2020	10,000 (model-based simulation)	Myomectomy
Robot-assisted Myomectomy versus Open Surgery: Cost-effectiveness Analysis	Boyer De Latour A	2025	France	2021 (costs in 2021 EUR)	99 patients (66 open myomectomy cases, 33 robotic-assisted myomectomy cases)	Robot-assisted myomectomy (RAM)
Uterine Artery Embolization, Hysterectomy, or Myomectomy for Symptomatic Uterine Fibroids: A Cost-Utility Analysis	You JHS	2009	Hong Kong	Approximately 2006 (currency conversion from HKD to USD in the same year)	Analysing a hypothetical population with fibroid symptoms using a model (not based on a randomised controlled trial, but using multiple RCT data sources)	Myomectomy

(106 abdominal myomectomy and 27 robot-assisted laparoscopic myomectomy) revealed that, even though the robotic approach is more expensive ($66,596 versus $37,480), the clinical results are on par with or better [15]. To ascertain cost-effectiveness, the authors stressed that a long-term assessment is required.

Robot-assisted myomectomy ($57,283 dollars) is roughly twice as expensive as abdominal myomectomy ($28,721 dollars), but it offers substantial clinical benefits, according to a study by Advincula et al. on 58 patients [28].

Long-term Economic Analysis

The cost-effectiveness of myomectomy over the long term has been the subject of conflicting research. The study by You et al. with a five-year horizon found hysterectomy to be more effective [24], while the study by Thao et al. with a lifetime horizon presented myomectomy as the most economical option [27]. Differences in the study population, time horizon, and model assumptions are probably the cause of this discrepancy.

Discussion

Evidence from 14 studies assessing the financial burden and cost-effectiveness of myomectomy for uterine fibroids across various healthcare systems was compiled

Comparator	Study Design	Type of Economic Evaluation	Analytical Perspective	Time Horizon	Sensitivity Analysis	Willingness-to-Pay Threshold	Key Findings
Comparative analysis among AM, LM, and RAM	Cost analysis using decision model	Cost-minimization analysis	Healthcare system perspective	Brief postoperative phase (undefined length, most likely treatment phase)	All parameters underwent a one-way sensitivity analysis.	Not relevant for cost-minimization analysis, or not applicable	Robotic-assisted myomectomy was the most costly procedure, while abdominal myomectomy showed the lowest cost.
Hysterectomy with or without oophorectomy	Markov decision-analytic model	Cost-effectiveness analysis	Healthcare system perspective	Lifetime	the model showed sensitivity to fibroid recurrence rates and quality-adjusted life years.	$100,000 per quality-adjusted life year (QALY)	The most economical treatment for uterine fibroids in women aged 40 was myomectomy.
Open myomectomy (OM)	Multicenter retrospective non-interventional study	Cost-effectiveness analysis	Hospital perspective	One month post-surgery	One-way sensitivity analysis and bootstrap were performed.	RAM showed a 50% likelihood of cost-effectiveness at this threshold, up to €71,000 per patient.	RAM was more expensive but led to fewer complications and a shorter hospital stay; the incremental cost-effectiveness ratio was higher, and RAM was not cost-effective at standard willingness-to-pay thresholds.
Hysterectomy and uterine artery embolization (UAE)	Probabilistic and deterministic elements in a Markov model	Cost-utility analysis (CUA)	Societal perspective	Five years	One-way and probabilistic Monte Carlo sensitivity analyses (10,000 iterations) were carried out.	Unreported (the manuscript does not specify the willingness-to-pay threshold)	During the five-year time frame, hysterectomy proved to be more cost-effective than myomectomy, which had lower QALYs and higher costs than hysterectomy but better QALYs than the UAE.

in this systematic review. Only four studies (28.6%) carried out comprehensive economic evaluations that included quality-adjusted life years (QALYs) or incremental cost-effectiveness ratios (ICERs), according to our analysis, which showed significant methodological heterogeneity. There is a substantial evidence gap in fertility-preserving interventions because the remaining studies were restricted to cost analyses.

Surgical technique, the features of the healthcare system, and the analytical viewpoint were the main causes of the observed cost variation, which ranged from $1,469 to $626,197 (international dollars 2024). This 450-fold disparity highlights important methodological flaws that restrict the synthesis of evidence and clinical judgement, as well as the difficulty of economic evaluation in gynaecological surgery.

Above all, our results show that the choice of time horizon significantly changes economic conclusions. While shorter-term analyses (≤5 years) frequently came to the opposite conclusion, studies using lifetime horizons consistently preferred myomectomy over hysterectomy. Given that the benefits of fertility preservation accrue over decades rather than months, this temporal sensitivity has significant ramifications for clinical guidelines and reimbursement decisions.

The methodological quality assessment found alarming flaws in all of the included research. Only 35.7% of the studies received high-quality ratings using validated

Tab. IV. Economic Outcomes and Cost-Effectiveness Results (PPP-Adjusted to 2024 International USD).

Study	First Author	Country	Original Costing Year	Myomectomy Cost (Original)	Myomectomy Cost (2024 I$)
Cost Analysis of Abdominal, Laparoscopic, and Robotic-Assisted Myomectomies	Behera MA	United States	2009 USD	AM: $4,937; LM: $6,219; RM: $7,299	AM: $7,008; LM: $8,828; RM: $10,361
Cost-effectiveness of Myomectomy versus Hysterectomy in Women with Uterine Fibroids	Thao V	United States	2020 USD	$528,217	$626,197
Robot-assisted Myomectomy versus Open Surgery: Cost-effectiveness Analysis	Boyer De Latour A	France	2021 EUR	RAM : €8,022	$11,445
Uterine Artery Embolization, Hysterectomy, or Myomectomy for Symptomatic Uterine Fibroids: A Cost-Utility Analysis	You JHS	Hong Kong	~2006 HKD	$9,036 (converted from HKD)	$2,234

QHES criteria, with specific shortcomings in perspective specification (90 percent of cost analyses lacked a clear analytical perspective) and uncertainty analysis (50 percent of studies did not provide an uncertainty assessment). The validity and applicability of economic evidence are seriously jeopardised by these constraints.

A significant methodological flaw in 70% of cost studies is the lack of sensitivity analysis, since robust health economic evaluation relies heavily on the quantification of uncertainty [35]. Additionally, the emphasis on short-term expenses (median follow-up: 12 months) consistently undervalues fertility-preserving measures whose advantages last throughout reproductive lifespans. There is an urgent need for standardized evaluation frameworks created especially for reproductive health interventions, and these methodological flaws reflect larger issues in the economic evaluation of fertility-preserving procedures.

Significant cost differences related to the healthcare system were found by our analysis, with significant equity implications. Harrington et al. found a 20.8% cost difference between commercial insurance ($17,797) and Medicaid coverage ($14,727) in the US alone, indicating that insurance type may affect access to treatment [34]. Given that women of reproductive age from a variety of socioeconomic backgrounds are disproportionately affected by uterine fibroids, this finding is especially alarming.

With European costs ranging from $1,469 (France) to $7,941 (England) across comparable healthcare systems, international comparisons further demonstrated system-level variations [28]. Rather than innate variations in clinical efficacy, these discrepancies most likely reflect variations in resource pricing, clinical pathways, and reimbursement structures. In addition to indicating that economic evidence might not be directly transferable across healthcare systems without suitable adaptation, this variation has significant ramifications for the development of international guidelines.

According to economic analysis, the mean incremental cost of robotic-assisted myomectomy (RAM) is €3,555 per procedure, which is significantly higher than that of open myomectomy (OM). Beyond the usual willingness-to-pay thresholds (usually €50,000-€100,000 per QALY), the incremental cost-effectiveness ratio (ICER) increased to €155,241 per complication avoided (main outcome: avoidance of transfusions or intraoperative blood loss ≥500 mL). Significantly, RAM decreased readmissions (0% *vs*. 1.21%; $p<0.01$) and hospital stays (2.98 *vs*. 4.34 days; $p<0.01$) without raising major complications, indicating clinically meaningful benefits that offset increased expenses [25].

However, the limited 1-month time horizon used in this analysis probably understated RAM's long-term benefits, such as decreased adhesion formation and enhanced fertility results. The elevated ICER (€155,241) reflects the current evidence that routine RAM adoption is not supported by economic considerations alone, even though cost-volume curves show potential economic improvements through optimised surgical volume (>1,976 annual procedures), learning curve mastery (operating time decreased after ~50 cases), and equipment cost reductions. Therefore, in order to confirm clinical superiority and cost effectiveness, longer-term comparative effectiveness research is still essential.

Our comparison of other treatment options showed that myomectomy ranked in the middle in terms of both cost and clinical results. Although transcervical fibroid ablation was the least expensive option ($11,406), concerns about fertility preservation and long-term durability still exist (29). On the other hand, although a hysterectomy is more expensive initially ($30,815), it resolves symptoms permanently but removes the ability to procreate.

Myomectomy is positioned as a beneficial compromise for women seeking to preserve fertility while maintaining manageable symptom control due to this economic-clinical trade-off. Using lifetime perspectives significantly boosts this approach's economic appeal and supports value-based healthcare frameworks that put long-term patient outcomes ahead of short-term cost reduction.

Comparator Cost (Original)	Comparator Cost (2024 I$)	QALY - Intervention	QALY - Comparator	ICER (2024 I$)	Conclusion
Same procedures compared	-	Not calculated	Not calculated	Not applicable (cost-minimization)	The most economical surgical procedure is an abdominal myomectomy.
Hysterectomy with oophorectomy: $550,183; without: $558,580	Hysterectomy with oophorectomy: $652,237; without: $662,192	19.38	With oophorectomy: 19.42; Without: 19.35	$726,877 per QALY	The most economical choice when taking long-term results into account is myomectomy.
OM : €4,467	$6,373	Not calculated	Not calculated	$221,484per complication-free patient	RAM is clinically better, but it is not cost-effective; optimisation is required.
UAE: $8,847; Hysterectomy: $8,418	UAE: $2,187; Hysterectomy: $2,081	4.273	UAE: 4.245; Hysterectomy: 4.368	$1,669	The most economical option is a hysterectomy when uterine preservation is not necessary.

Our analysis found important indirect economic effects that are frequently overlooked in payer-focused assessments, in addition to direct healthcare costs. After a myomectomy, Carls et al. showed significant increases in work productivity and decreased absenteeism, which could have a positive social impact and partially offset the higher initial treatment costs [33].

Rather than restricting analysis to the costs of the healthcare sector, these findings support broader economic evaluation perspectives that capture societal value creation. These methods are especially pertinent to fertility-preserving interventions, that offer long-term quality of life, reproductive autonomy, and flexibility in family planning in addition to immediate symptom relief.

Limitations

This systematic review has several important limitations that should be considered when interpreting the findings. First, substantial methodological heterogeneity in study design, outcome measures, and analytical approaches prevented a pooled quantitative synthesis of cost-effectiveness data. The under-representation of studies from low- and middle-income countries further limits the global generalisability of our results, given regional differences in healthcare systems and economic contexts. Restricting the search to English-language publications may have introduced selection bias and excluded relevant non-English studies, particularly from regions where innovative gynaecological interventions are practiced. Rapid advances in surgical techniques, medical technologies, and healthcare delivery models may also mean that some included economic evaluations do not fully reflect current clinical or cost structures. Variations in costing methods, currency adjustments, and analytical perspectives across studies further constrain comparability and transferability of cost-effectiveness estimates. Differences in patient populations, comorbidities, and healthcare environments may affect the external validity of our findings. Publication bias could also have inflated perceived cost-effectiveness by favouring studies with positive economic outcomes. Moreover, the variable quality of included studies – some lacking long-term follow-up or comprehensive sensitivity analyses – may weaken the robustness of conclusions. Finally, the absence of standardised outcome measures across gynaecological economic studies limits direct comparisons and may impede policy development and clinical decision-making.

Conclusion

This systematic review identified major evidence gaps in economic evaluations of myomectomy that affect clinical and policy decisions. Among 14 studies, only 28.6% conducted comprehensive economic evaluations, with large cost variations ($1,469-$626,197 International Dollars 2024) primarily reflecting methodological inconsistencies. Analytical time horizon was the main determinant of cost-effectiveness: short-term models favoured hysterectomy (ICER: $1,669/QALY), while lifetime analyses favoured myomectomy (ICER: $726,877/QALY). Quality assessment revealed critical flaws – only 35.7% achieved high QHES scores, 90% lacked a defined analytical perspective, and half omitted uncertainty analyses – undermining evidence validity. Robotic-assisted myomectomy showed significantly higher costs ($57,283-$66,596 *vs*. $28,721-$37,480) without robust cost-effectiveness support. International cost disparities highlight the influence of healthcare systems and raise equity concerns related to insurance coverage and treatment access. Future research should adopt standardised, long-term economic frameworks that incorporate reproductive outcomes and broader societal benefits to better guide evidence-based policy and reimbursement decisions.

Tab. V. Characteristics and Key Findings of Cost Analysis Studies.

Study Title	First Author	Publication Year	Country	Sample Size
Rate, Type, and Cost of Invasive Interventions for Uterine Myomas in Germany, France, and England	Fernandez H	2009	Germany, France, United Kingdom	Germany: 64,299; France: 37,787; UK: 18,274
Robot-assisted Laparoscopic Myomectomy *vs.* Abdominal Myomectomy: Short-term Outcomes and Costs	Advincula AP	2007	United States	58 patients (29 robotic-assisted, 29 abdominal myomectomy)
Direct Costs Among Women Undergoing Surgical Procedures for Uterine Fibroids	Harrington A	2020	United States	113,091 patients (103,814 commercial insurance, 9,277 Medicaid)
The INSPIRE Study: 12-Month Economic Outcomes of Hysterectomy, Myomectomy, and Sonata System	Brooks E	2020	United States	8,548 patients (myomectomy group) 44011(total patients)
What Are the Total Costs of Surgical Treatment for Uterine Fibroids?	Carls GS	2008	United States	22,860 patients (surgical), 14,214 patients (non-surgical)
Cost Analysis of Invasive Treatments for Symptomatic Uterine Fibroids	Cronan J	2020	United States	11,344 patients (myomectomy group) 229897 (total patients)
Payer Costs for UAE, Hysterectomy, or Myomectomy	Dembek CJ	2007	United States	2,836 hysterectomy, 704 myomectomy, 125 UAE patients
Cost Analysis of Myomectomy, Hysterectomy, and UAE	Al-Fozan H	2002	Canada	545 women
Cost and Reimbursement for Fibroid Treatments: Abdominal Hysterectomy, Abdominal Myomectomy, UFE	Goldberg J	2007	United States	540 patients (105 abdominal myomectomy)
Robotic-assisted Laparoscopic *vs.* Abdominal Myomectomy: Surgical Outcomes & Costs	Nash K	2011	United States	133 patients (27 robotic-assisted laparoscopic myomectomy, 106 abdominal myomectomy)

Ethics approval and consent to participate

The Research Ethics Committee of the Iran University of Medical Sciences provided the ethical approval for this study (IR.IUMS.REC.1403.1034) previously. All methods were performed in accordance with the relevant guidelines and regulations such as Declarations of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests Statement

The authors declare that they have no competing interests.

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Authors' contributions

BDT, AA, and MB contributed to the conception and design of the study. BDT, AS conducted the search, and MB was co-moderator. BDT, AS, MB, AR, and AA conducted screening and selecting the final studies, which SR discussed regularly. BDT, AA, AS, MB, AR, and SR wrote the initial draft and contributed to manuscript revisions. BDT, MM, MB: performed a search of the literature. BDT, MB, MM: editing All authors read and confirmed the final manuscript.

Intervention	Comparator	Study Design	Economic Perspective	Conclusion
Abdominal, laparoscopic, hysteroscopic, and vaginal myomectomy	Hysterectomy	National registry-based hospitalization data	Healthcare payer perspective	Decision-makers in healthcare can benefit greatly from the cost data from three European nations.
Robot-assisted laparoscopic myomectomy	Traditional abdominal myomectomy	Retrospective case-matched study	Hospital and third-party payer perspectives	Despite the higher initial costs, robotic-assisted myomectomy may be socioeconomically cost-effective.
Abdominal, traditional laparoscopic, robotic laparoscopic myomectomy	Hysterectomy, UAE, ablation, myomectomy + ablation	Retrospective cohort using administrative claims data	Healthcare payer perspective	Cost-effective substitutes are required because surgical fibroid treatments are very expensive.
Myomectomy (uterus-preserving approach)	Hysterectomy, Transcervical Fibroid Ablation (TFA, Sonata system)	Retrospective and prospective cost comparison	Healthcare payer perspective	Hysterectomy was the most costly treatment option, while TFA showed the lowest cost.
Myomectomy	Hysterectomy, UAE, ablation, non-surgical options	Secondary analysis of insurance claims	Healthcare payer and employer perspectives	Because there are fewer missed workdays, myomectomy may lessen the burden on employers.
Myomectomy	Hysterectomy, uterine fibroid embolization (UFE), endometrial ablation	Claims-based economic study	Healthcare payer perspective	Myomectomy is more common in younger and urban women, but it is used less frequently despite having comparable costs.
Myomectomy	Hysterectomy, UAE	Retrospective insurance claims analysis	Healthcare payer perspective	UAE follow-up imaging raises expenses, but overall costs are similar for all treatment modalities.
Myomectomy	Abdominal/vaginal hysterectomy, UAE	Retrospective hospital data review	Inpatient/hospital perspective	Although the UAE was much less expensive, it was linked to higher rates of readmission for pain management.
Abdominal myomectomy	Abdominal hysterectomy, UFE	Retrospective hospital database analysis	Institutional perspective	Although both myomectomy and hysterectomy have negative net revenue, their costs are similar.
Robotic-assisted laparoscopic myomectomy (RALM)	Abdominal myomectomy	Retrospective comparative analysis using propensity score matching	Hospital perspective	RALM exhibits similar or better clinical outcomes in the short term, but its cost-effectiveness needs to be assessed over the long run.

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References

[1] Ahmad A, Kumar M, Bhoi NR, Badruddeen, Akhtar J, Khan MI, Ajmal M, Ahmad M. Diagnosis and management of uterine fibroids: current trends and future strategies. J Basic Clin Physiol Pharmacol 2023;34:291-310. https://doi.org/10.1515/jbcpp-2022-0219.

[2] Fuldeore MJ, Soliman AMJIjowsh. Patient-reported prevalence and symptomatic burden of uterine fibroids among women in the United States: findings from a cross-sectional survey analysis. Int J Womens Health 2017;9:403-11. https://doi.org/10.2147/IJWH.S133212.

[3] Sefah N, Ndebele S, Prince L, Korasare E, Agbleke M, Nkansah A, Thompson H, Al-Hendy A, Agbleke AA. Uterine fibroids – Causes, impact, treatment, and lens to the African perspective. Front Pharmacol 2023;13:1045783. https://doi.org/10.3389/fphar.2022.1045783.

[4] Millien C, Manzi A, Katz AM, Gilbert H, Smith Fawzi MC, Farmer PE,, Mukherjee J. Assessing burden, risk factors, and perceived impact of uterine fibroids on women's lives in rural Haiti: implications for advancing a health equity agenda, a mixed methods study. Int J Equity Health 2021;20:1. https://doi.org/10.1186/s12939-020-01327-9.

[5] Moroni R, Vieira C, Ferriani R, Candido-Dos-Reis F, Brito L. Pharmacological treatment of uterine fibroids. Annals of medical and health sciences research. Ann Med Health Sci Res 2014;4(Suppl 3):S185-92. https://doi.org/10.4103/2141-9248.141955.

[6] Szkodziak F, Woźniak S, Światłowski Ł, Maleszyk E, Szkodziak P, Pyra K, Berczi V, Paszkowski T, Jargiełło T. Preoperative uterine artery embolisation before hysterectomy in women with giant uterine fibroid and HIV-associated nephropathy. Case Reports 2024;23:159-62. https://doi.org/10.5114/pm.2024.143483.

[7] Szkodziak P, Szkodziak F, Trzeciak K, Czuczwar P. Minimally invasive procedures in the management of uterine fibroids. Prz Menopauzalny 2017;16:122-5. https://doi.org/10.5114/pm.2017.72756.

Tab. VI. Cost Analysis Studies Characteristics and PPP-Adjusted Economic Outcomes (2024 International USD).

Study Title	First Author	Publication Year	Country	Original Costing Year	Sample Size
Rate, Type, and Cost of Invasive Interventions for Uterine Myomas	Fernandez H	2009	Germany, France, UK	2005	Germany: 64,299; France:37,787; UK: 18,274
Robot-assisted Laparoscopic Myomectomy *vs.* Abdominal Myomectomy	Advincula AP	2007	United States	2004	58 patients
Direct Costs Among Women Undergoing Surgical Procedures for Uterine Fibroids	Harrington A	2020	United States	2017	113,091 patients
The INSPIRE Study: 12-Month Economic Outcomes	Brooks E	2020	United States	2016	44011 patients
What Are the Total Costs of Surgical Treatment for Uterine Fibroids?	Carls GS	2008	United States	2005	22,860 patients
Cost Analysis of Invasive Treatments for Symptomatic Uterine Fibroids	Cronan J	2020	United States	2015	229897 patients
Payer Costs for UAE, Hysterectomy, or Myomectomy	Dembek CJ	2007	United States	2002	3,665 patients
Cost Analysis of Myomectomy, Hysterectomy, and UAE	Al-Fozan H	2002	Canada	2001	545 women
Cost and Reimbursement for Fibroid Treatments	Goldberg J	2007	United States	2002	540 patients
Robotic-assisted Laparoscopic *vs.* Abdominal Myomectomy	Nash K	2011	United States	2010	133 patients

[8] Park SY, Kim J, Jeong K, Jung SI, Hur YM, Cho EH, Moon HS, Chung HW. Clinical experience of robotic myomectomy for fertility preservation using preoperative magnetic resonance imaging predictor. Obstet Gynecol Sci 2020;63:726-34. https://doi.org/10.5468/ogs.20145.

[9] Tahapary M, Timmerman S, Ledger A, Dewilde K, Froyman W. Implementation of robot-assisted myomectomy in a large university hospital: a retrospective descriptive study. Facts Views Vis Obgyn 2023;15:243-50. https://doi.org/10.52054/FVVO.15.3.089.

[10] Yılmaz S, Usta T, Kaya E, Topbaş Selçuki NFJCM. Laparoscopic versus laparotomic myomectomy: a retrospective cohort study. Compreh Med 2023;15:262-7. https://doi.org/10.14744/cm.2023.14633.

[11] Chen W, Ma J, Yang Z, Han X, Hu C, Wang H, Peng Y, Zhang L, Jiang B. Robotic-assisted laparoscopic versus abdominal and laparoscopic myomectomy: A systematic review and meta-analysis. Int J Gynaecol Obstet 2024;166:994-1005. https://doi.org/10.1002/ijgo.15485.

[12] Brown MMJCoio. Health care economic analyses. Curr Opin Ophthalmol 2003;14:117-21. https://doi.org/10.1002/ijgo.15485.

[13] Al-Fozan H, Dufort J, Kaplow M, Valenti D, Tulandi TJA-joo, gynecology. Cost analysis of myomectomy, hysterectomy, and uterine artery embolization. Am J Obstet Gynecol 2002;187:1401-4. https://doi.org/10.1067/mob.2002.127374.

[14] Goldberg J, Bussard A, McNeil J, Diamond JJC, Radiology I. Cost and reimbursement for three fibroid treatments: abdominal hysterectomy, abdominal myomectomy, and uterine fibroid embolization. Cardiovasc Intervent Radiol 2007;30:54-8. https://doi.org/10.1007/s00270-005-0369-5.

[15] Nash K, Feinglass J, Zei C, Lu G, Mengesha B, Lewicky-Gaupp C, Lin A. Robotic-assisted laparoscopic myomectomy versus abdominal myomectomy: a comparative analysis of surgical outcomes and costs. Arch Gynecol Obstet 2012;285:435-40. 10.1007/s00404-011-1999-2.

[16] Büchter RB, Weise A, Pieper D. Development, testing and use of data extraction forms in systematic reviews: a review of meth-

Myomectomy Cost (Original)	Myomectomy Cost (2024 I$)	Comparator Cost (Original)	Comparator Cost (2024 I$)	Study Design	Key Economic Finding
Germany: €2,260 France: €842-2,734 UK: €1,056-3,440	Germany: $4,322 France: $1,469-4,771 UK: $2,438-7,941	Germany: €3,316-4,310 France: €3,404-4,664 UK: €3,440	Germany: $6,342-8,243 France: $5940 -8,139 UK: $7,941	National registry-based	The cost of a hysterectomy is continuously higher in all three healthcare systems.
$36,030 (total cost)	$57,283	$18,065	$28,721	Retrospective case-matched	The robotic approach has clinical benefits but costs almost twice as much.
Commercial: $14,216 Medicaid: $11,764	Commercial: $17,797 Medicaid: $14,727	Commercial: $17,450 Medicaid: $12,273	Commercial: $21,846 Medicaid: $15,364	Retrospective cohort	Procedural costs are greatly impacted by the type of insurance.
$22,784 (average)	$29,065	Hysterectomy: $24,156 TFA: $8,941	Hysterectomy: $30,815 TFA: $11,406	Retrospective and prospective	TFA demonstrated lowest cost option
Unadjusted: $14,726 Adjusted: $18,674	Unadjusted: $22,701 Adjusted: $28,787	Unadjusted: $15,180 Adjusted: $17,390	Unadjusted: $23,400 Adjusted: $26,807	Secondary analysis	Lower myomectomy expenses overall because of lower indirect costs
$4,436 (procedure only)	$5,716	Hysterectomy: $3,188 Ablation: $2,781 UFE: $6,161	Hysterectomy: $4,108 Ablation: $3,583 UFE: $7,938	Claims-based economic study	The cost of myomectomy is in between that of ablation and UFE.
$7,299 (median cost)	$10,257	Hysterectomy: $7,707 UAE: $5,968	Hysterectomy: $12,830 UAE: $9,935	Retrospective insurance claims	Variations in follow-up but similar median costs across treatments
C$1,781.73±47.16	$2,520	Total hysterectomy: C$1,933.37±47.68 Vaginal hysterectomy: C$1,515.39±66.72 UAE: C$1,007.44±60.65	Total hysterectomy: $2,734 Vaginal hysterectomy: $2,143 UAE: $1,425	Retrospective hospital review	UAE has the lowest initial costs, but readmission rates are higher.
$5,676 (mean total cost)	$9,449	Hysterectomy: $5,707 UFE: $2,707	Hysterectomy: $9,501 UFE: $4,507	Retrospective hospital database	Hysterectomy and myomectomy have comparable costs.
$47,478 (total hospital cost)	$66,596	$26,720 (abdominal myomectomy)	$37,480	Retrospective comparative analysis	RALM has clinical benefits, but the costs are much higher.

odological guidance. BMC Med Res Methodol 2020;20:259. https://doi.org/10.1186/s12874-020-01143-3.

[17] Shemilt I, James T, Marcello M. A web-based tool for adjusting costs to a specific target currency and price year. Evid Policy 2010;6:51-9. https://doi.org/10.1332/174426410X482999

[18] World Bank. PPP conversion factor, GDP (LCU per international $). 2024. Available at: https://data.worldbank.org/indicator/PA.NUS.PPP. Accessed on: 2026 June 16.

[19] Organisation for Economic Co-operation and Development. Purchasing power parities (PPP) : OECD Statistics . 2024. Available at: https://stats.oecd.org/Index.aspx?DataSetCode=PPP. Accessed on: 2026, June 17.

[20] Chiou CF, Hay JW, Wallace JF, Bloom BS, Neumann PJ, Sullivan SD, Yu HT, Keeler EB, Henning JM, Ofman JJ. Development and validation of a grading system for the quality of cost-effectiveness studies. Medical Care 2003;41:32-44. https://doi.org/10.1097/00005650-200301000-00007.

[21] Larg A, Moss JR. Cost-of-illness studies: a guide to critical evaluation. PharmacoEconomics 2011;29:653-71. https://doi.org/10.2165/11588380-000000000-00000.

[22] Crowther M, Lim W, Crowther MA. Systematic review and meta-analysis methodology. Blood 2010;116:3140-6. https://doi.org/10.1182/blood-2010-05-280883.

[23] ong A, Flemming K, McInnes E, Oliver S, Craig J. Enhancing transparency in reporting the synthesis of qualitative research: ENTREQ. BMC Med Res Methodol 2012;12:181. https://doi.org/10.1186/1471-2288-12-181.

[24] You JH, Sahota DS, Yuen PM. Uterine artery embolization, hysterectomy, or myomectomy for symptomatic uterine fibroids: a cost-utility analysis. Fertil Steril 2009;91:580-8. https://doi.org/10.1016/j.fertnstert.2007.11.078.

[25] Boyer De Latour A, Vappereau A, Le Bras A, Favier A, Koskas M, Borghese B, Uzan C, Durand-Zaleski I, Canlorbe G. Robot-assisted myomectomy versus open surgery: Cost-effectiveness analysis. J Gynecol Obstet Hum Reprod 2025;54:102887. https://doi.org/10.1016/j.jogoh.2024.102887.

[26] Behera MA, Likes CE, 3rd, Judd JP, Barnett JC, Havrilesky LJ, Wu JM. Cost analysis of abdominal, laparoscopic, and robotic-assisted myomectomies. J Minim Invasive Gynecol 2012;19:52-7. https://doi.org/10.1016/j.jmig.2011.09.007.

[27] Thao V, Moriarty JP, Stewart EA, Borah BJ. Cost-effectiveness of Myomectomy versus Hysterectomy in Women with Uterine Fibroids. J Minim Invasive Gynecol 2023;30:813-9. https://doi.org/10.1016/j.jmig.2023.06.001.

[28] Advincula AP, Xu X, Goudeau St, Ransom SB. Robot-assisted laparoscopic myomectomy versus abdominal myomectomy: a comparison of short-term surgical outcomes and immediate costs. J Minim Invasive Gynecol 2007;14:698-705. https://doi.org/10.1016/j.jmig.2007.06.008.

[29] Brooks E, Mihalov L, Delvadia D, Hudgens J, Mama S, Makai GE, Yuen MW, Little CA, Bauserman RL, Zambelli-Weiner A, Levine DJ. The INSPIRE Comparative Cost Study: 12-Month Health Economic and Clinical Outcomes Associated with Hysterectomy, Myomectomy, and Treatment with the Sonata System. Clinicoecon Outcomes Res 2020;12:1-11. https://doi.org/10.2147/CEOR.S214755.

[30] Carls GS, Lee DW, Ozminkowski RJ, Wang S, Gibson TB, Stewart E. What are the total costs of surgical treatment for uterine fibroids? J Womens Health (Larchmt) 2008;17:1119-32. https://doi.org/10.1089/jwh.2008.0456.

[31] Cronan J, Horný M, Duszak R, Jr., Newsome J, Carlos R, Hughes DR, Memula S, Kokabi N. Invasive Procedural Treatments for Symptomatic Uterine Fibroids: A Cost Analysis. J Am Coll Radiol 2020;17:1237-44. https://doi.org/10.1016/j.jacr.2020.03.018.

[32] Dembek CJ, Pelletier EM, Isaacson KB, Spies JB. Payer costs in patients undergoing uterine artery embolization, hysterectomy, or myomectomy for treatment of uterine fibroids. J Vasc Interv Radiol 2007;18:1207-13. https://doi.org/10.1016/j.jvir.2007.07.007.

[33] Fernandez H, Farrugia M, Jones SE, Mauskopf JA, Oppelt P, Subramanian D. Rate, type, and cost of invasive interventions for uterine myomas in Germany, France, and England. J Minim Invasive Gynecol 2009;16:40-6. https://doi.org/10.1016/j.jmig.2008.09.581.

[34] Harrington A, Bonine NG, Banks E, Shih V, Stafkey-Mailey D, Fuldeore RM, Yue B, Ye JM, Ta JT, Gillard P. Direct Costs Incurred Among Women Undergoing Surgical Procedures to Treat Uterine Fibroids. J Manag Care Spec Pharm 2020;26(1-a Suppl):S2-s10. https://doi.org/10.18553/jmcp.2020.26.1-a.s2.

[35] Husereau D, Drummond M, Augustovski F, de Bekker-Grob E, Briggs AH, Carswell C, Caulley L, Chaiyakunapruk N, Greenberg D, Loder E, Mauskopf J, Mullins CD, Petrou S, Pwu RF, Staniszewska S; CHEERS 2022 ISPOR Good Research Practices Task Force. Consolidated Health Economic Evaluation Reporting Standards 2022 (CHEERS 2022) Statement: Updated Reporting Guidance for Health Economic Evaluations. Value Health 2022;25:3-9. https://doi.org/10.1016/j.jval.2021.11.1351.

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HEALTH CARE MANAGEMENT

Embedding political economy in Iran's health policy cycle: necessity and pathways

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Keywords

Political Economy Analysis • Health Policy • Health System Reform • Policy Cycle • Iran • Health Governance

Summary

Health policy is often presented as a technical process guided by scientific evidence and managerial expertise. However, policy decisions are equally shaped by political institutions, economic constraints, stakeholder interests, and power relations. In Iran, these political-economic dimensions remain insufficiently integrated into health policymaking despite their substantial influence on policy formulation, implementation, and sustainability. This viewpoint argues that political economy analysis (PEA) should be institutionalized throughout the health policy cycle as a core component of evidence-informed decision-making. Drawing on the characteristics of Iran's health system, the article identifies four interrelated factors that underscore this need: institutional fragmentation, fiscal instability associated with a rentier economy and economic sanctions, discontinuity arising from political transitions, and the influence of organized interest groups. These factors illustrate why technically sound reforms may fail to achieve sustainable outcomes when political and institutional realities are overlooked. Building on this analysis, the article proposes four practical pathways for institutionalizing PEA: introducing a mandatory Political Economy Annex for major policy proposals, establishing a permanent Political Economy Advisory Unit, strengthening capacity through education and professional training, and promoting long-term policy–research partnerships. Collectively, these recommendations provide an operational framework for embedding political economy considerations into routine health policymaking. Institutionalizing PEA will not eliminate political conflict from health policy; rather, it will improve policymakers' ability to anticipate competing interests, enhance the political legitimacy of reforms, manage implementation challenges, and design reforms that are both technically effective and politically sustainable.

What is health policy and why does it matter?

Health policy is commonly defined as the set of decisions, plans, and actions undertaken by governments and other institutions to achieve specific health goals within a society [1]. These goals generally include improving population health, ensuring equitable access to health services, protecting households from financial hardship, and maintaining the quality, safety, and efficiency of healthcare delivery [2]. Although this definition appropriately captures the technical dimensions of policymaking, it does not fully reflect the complex political and economic context within which health policies are formulated and implemented. Health policy is not simply a rational or evidence-informed process in which policymakers identify a problem, evaluate scientific evidence, and adopt the most effective intervention. Rather, it is a dynamic process shaped by competing priorities, institutional arrangements, resource constraints, and interactions among multiple actors with differing interests [3].

The significance of health policy extends well beyond the health sector itself. Health is widely recognized as a fundamental human right and an essential component of social and economic development [4]. Consequently, decisions regarding the allocation of health resources have profound implications for equity, economic productivity, social welfare, and public confidence in government institutions [5]. In Iran, as in many middle-income countries, health expenditure accounts for a considerable proportion of national public spending, making health policy a major determinant of fiscal sustainability as well as population wellbeing. Poorly designed policies may result in inefficient resource allocation, widening inequities, financial hardship for households, and deterioration in public trust, whereas effective policies can improve health outcomes while simultaneously strengthening social cohesion and economic resilience [6].

Despite this importance, health policy is frequently conceptualized as a predominantly technical exercise [7]. Such a perspective implicitly assumes that stronger scientific evidence, improved managerial capacity, and more sophisticated analytical tools are sufficient to produce successful reforms [8]. However, experience from numerous health systems

demonstrates that technically sound policies often fail because they encounter political resistance, institutional fragmentation, conflicting stakeholder interests, or fiscal constraints that were not adequately anticipated during policy design [9]. Consequently, policy success depends not only on the quality of technical evidence but also on the political and institutional environment in which policies are developed and implemented [10].

In practice, every major health policy decision is embedded within a network of formal institutions, informal rules, competing interests, and power relationships [11]. Decisions regarding health financing, provider payment mechanisms, pharmaceutical regulation, insurance coverage, or priority setting are rarely determined solely by scientific evidence [12]. Instead, they emerge through negotiation among governmental organizations, professional associations, private sector actors, civil society organizations, and other stakeholders whose interests may converge or conflict [13]. The eventual policy outcome therefore reflects not only the available evidence but also the relative influence, bargaining power, and institutional position, and the prevailing ideas and cultural norms of these actors [14]. Understanding health policy thus requires examining who participates in decision-making, whose interests are prioritized, and which institutional arrangements facilitate or constrain policy change [15].

This perspective provides the foundation for the central argument of this viewpoint. Many explanations for unsuccessful health reforms emphasize deficiencies in evidence translation, managerial capacity, or implementation processes. Although these factors are important, they often represent the observable manifestations of deeper political and economic dynamics. Policy failures frequently arise because insufficient attention is paid to stakeholder incentives, institutional structures, power asymmetries, fiscal realities, and broader political contexts that ultimately determine whether reforms become politically feasible and sustainable. Accordingly, political economy analysis should not be regarded as an optional complement to conventional policy analysis, but rather as an essential analytical framework for understanding, designing, implementing, and evaluating health policies, particularly in complex health systems such as that of Iran.

What is political economy analysis and how does it affect health systems?

Political economy analysis (PEA) is an analytical approach that examines how power, institutions, ideas, and economic interests interact to shape public policy and its outcomes [17]. Although the term is sometimes associated primarily with economics or electoral politics, its scope is considerably broader. Rather than focusing exclusively on economic efficiency or political competition, PEA seeks to explain why particular policies emerge, whose interests they serve, and why implementation succeeds or fails under specific institutional and political conditions [18]. Unlike conventional economic evaluation, which primarily asks whether an intervention is cost-effective, PEA asks complementary questions: Who possesses decision-making authority? Which actors are likely to support or oppose reform? What formal and informal institutions shape policy choices? And how do prevailing ideas and political narratives influence what is considered feasible or legitimate? These questions are fundamental to understanding health policy because technically sound interventions frequently encounter barriers that cannot be explained by technical evidence alone [19].

Contemporary political economy frameworks generally emphasize four interrelated dimensions [20]. The first concerns actors and interests, requiring systematic identification of relevant stakeholders, their objectives, resources, incentives, and relative influence over policymaking [21]. The second dimension focuses on institutions, encompassing not only formal organizations and legal frameworks but also informal norms, routines, unwritten rules, and decision-making practices that often govern policy processes in practice, particularly in hierarchical bureaucracies [22]. The third dimension examines ideas and narratives, including dominant beliefs, policy paradigms, and societal discourses that influence how health problems are defined and which policy solutions become politically acceptable [23]. Finally, PEA considers broader political and economic structures, such as fiscal conditions, macroeconomic arrangements, dependence on natural resources, demographic pressures, and geopolitical factors that shape the policy environment [24]. Together, these dimensions provide a comprehensive framework for understanding why similar health policies produce different outcomes across countries and institutional settings [25].

Applying PEA fundamentally changes how health system performance is interpreted. Conventional health system analyses often attribute policy shortcomings to technical limitations, including insufficient financing, weak management capacity, inadequate infrastructure, or shortages of skilled personnel [26]. Although these factors are important, they frequently represent the consequences of deeper political and institutional processes rather than their underlying causes [27]. For example, persistent underinvestment in primary healthcare may reflect political priorities that favor hospital-based services, stronger lobbying by urban medical interests, or institutional incentives that allocate resources toward curative rather than preventive care [28]. Likewise, inefficiencies in pharmaceutical procurement or health financing may arise not solely from administrative weaknesses but also from governance arrangements, accountability deficits, and incentives that permit rent-seeking behavior [29]. By shifting attention from what is happening to why it is happening, PEA enables policymakers to identify structural barriers that conventional technical analyses may overlook [30].

The value of PEA extends across every stage of the

health policy cycle. During agenda-setting, it helps explain why certain health problems receive political attention while others remain neglected, enabling advocates to frame issues in ways that resonate with influential decision-makers [31]. During policy formulation, PEA facilitates identification of potential winners and losers, allowing policymakers to anticipate resistance, negotiate compromises, and build supportive coalitions before implementation begins [32]. During implementation, it identifies institutional bottlenecks, organizational resistance, and governance challenges that may compromise policy execution [33]. Finally, during evaluation, PEA provides a deeper understanding of policy performance by distinguishing between technical shortcomings and failures arising from political, institutional, or economic constraints [34]. Experiences from countries such as Thailand, Turkey, and Rwanda illustrate that incorporating political economy considerations can contribute substantially to the successful implementation of complex health reforms, including universal health coverage, health financing reforms, and tobacco control policies [35].

Conversely, neglecting political economy considerations exposes health reforms to predictable risks. Policies that are technically robust may nevertheless prove politically infeasible if they threaten influential stakeholders or fail to account for institutional realities [36]. Even reforms that initially achieve measurable success may lose momentum because of changes in political leadership, fiscal pressures, bureaucratic resistance, or declining stakeholder support [37]. Furthermore, the absence of systematic political economy analysis limits institutional learning, as the political determinants of previous policy successes and failures remain insufficiently documented and therefore cannot inform future reforms [38]. Consequently, integrating PEA into health policymaking should be viewed not merely as an analytical enhancement but as a fundamental requirement for designing policies that are both technically effective and politically sustainable.

The necessity of using political economy analysis in Iran's health system

The need to integrate PEA into Iran's health system is rooted in the country's distinctive institutional, economic, and political context. Although many health systems face governance challenges, Iran presents a particularly compelling case because multiple structural factors simultaneously influence health policymaking and implementation [38]. These factors include institutional fragmentation, fiscal uncertainty, political discontinuity, and the influence of organized interest groups, all of which interact to shape policy outcomes beyond what technical analyses alone can adequately explain [39].

First, Iran's health governance is characterized by a highly fragmented institutional architecture [40]. Unlike health systems in which policymaking authority is concentrated within a single organization, responsibility in Iran is distributed among multiple governmental and quasi-governmental institutions [41]. The Ministry of Health and Medical Education (MOHME) shares responsibilities with organizations such as the Plan and Budget Organization (PBO), the Social Security Organization (SSO), military health services, charitable foundations, and several public insurance organizations, each possessing distinct legal mandates, financial resources, and organizational priorities [42]. Although such institutional diversity can potentially increase system capacity, it also creates substantial coordination challenges, overlapping responsibilities, and competing policy priorities [43]. Consequently, reforms frequently depend not only on technical quality but also on the ability to negotiate institutional interests and build consensus among multiple decision-makers [44]. PEA provides a structured framework for identifying these actors, understanding their incentives, and anticipating potential sources of support or resistance before reforms are implemented.

Second, the structure of Iran's economy reinforces the need for political economy analysis [45]. The country's dependence on oil revenues, combined with prolonged economic sanctions, exposes the health sector to persistent fiscal volatility and uncertainty [46]. Currency depreciation substantially increases the costs of imported medicines, medical technologies, and pharmaceutical raw materials, while periods of fiscal constraint often require governments to make difficult budgetary trade-offs among competing sectors [47]. These decisions extend beyond technical budgeting exercises because they involve political choices regarding resource allocation, distributional priorities, and protection of vulnerable populations. Consequently, policies designed under assumptions of stable financing may become difficult to sustain when economic conditions change [48]. Incorporating PEA into the policy process enables decision-makers to consider fiscal risks, identify politically acceptable financing strategies, and develop contingency plans for periods of economic instability [49].

Third, political dynamics substantially influence the continuity and sustainability of health reforms in Iran [50]. Changes in political leadership and administrative priorities may alter the direction of health policies, affecting implementation even when reforms are technically well designed. The Health Transformation Plan (HTP), introduced in 2014, illustrates this challenge [51]. The reform achieved important early improvements, including reductions in out-of-pocket expenditure and expansion of hospital services [52]. However, its longer-term implementation was increasingly constrained by fiscal pressures, institutional disagreements, and changing political priorities. Although these challenges cannot be attributed solely to the absence of political economy analysis, they illustrate how insufficient attention to stakeholder incentives, long-term financing arrangements, and institutional ownership may undermine policy sustainability [53]. A systematic PEA conducted during

policy design could have helped identify potential risks, strengthen stakeholder engagement, and support mechanisms that enhanced resilience across successive political administrations.

Finally, the influence of organized interest groups further demonstrates the importance of PEA within Iran's health system. Stakeholders including pharmaceutical manufacturers, medical equipment suppliers, private healthcare providers, and professional medical associations, and influential semi-public entities such as military-affiliated health organizations, possess varying degrees of influence over policy decisions through their technical expertise, organizational capacity, and established relationships with policymakers [54]. Their participation is an inevitable component of health governance; however, differences in bargaining power may lead to policy outcomes that do not always align with broader public health objectives [55]. Decisions concerning physician payment mechanisms, pharmaceutical pricing, insurance benefit packages, and specialist workforce planning are therefore influenced by both scientific evidence and stakeholder negotiation [56]. The presence of military-affiliated health organizations, which operate across pharmaceutical production, medical equipment supply, and service delivery, adds an additional layer of complexity to health governance in Iran. These entities often possess substantial financial resources, political connections, and operational autonomy, making their interests particularly influential in policy decisions. PEA offers a systematic approach for making these relationships more transparent, identifying potential conflicts of interest, and strengthening governance mechanisms that promote accountability and balanced decision-making.

Taken together, these institutional, economic, political, and stakeholder-related factors demonstrate that the principal challenges facing Iran's health system cannot be fully understood through technical analysis alone. Rather, they reflect interactions among governance structures, political incentives, and economic realities that shape the feasibility, implementation, and sustainability of health reforms. Recognizing these dynamics provides the rationale for moving beyond diagnosis toward practical institutional solutions, which are discussed in the following section.

Practical pathways for institutionalizing PEA in Iran

Recognizing the importance of PEA is only the first step; the greater challenge is translating this perspective into routine policymaking practice. Many discussions acknowledge the relevance of political factors in health policy but provide limited guidance on how political economy analysis can be systematically incorporated into existing governance structures. Accordingly, this viewpoint proposes four complementary pathways that are both institutionally feasible and responsive to the specific characteristics of Iran's health system. Rather than representing isolated interventions, these pathways should be viewed as mutually reinforcing mechanisms that collectively strengthen evidence-informed and politically feasible policymaking.

Introduce a mandatory political economy annex for major health policies

The first priority should be the institutionalization of political economy assessment within the policy development process itself. One practical mechanism would be the introduction of a mandatory Political Economy Annex accompanying all major health policy proposals submitted to national decision-making bodies. Similar to fiscal or regulatory impact assessments, this annex would require policymakers to evaluate the political and institutional context before implementation rather than after challenges emerge. The annex should systematically assess stakeholder interests, potential sources of political support and opposition, institutional barriers to implementation, and fiscal or governance risks that could threaten policy sustainability. Embedding these questions into routine policy preparation would encourage policymakers to anticipate implementation challenges at an early stage instead of responding to them reactively. To ensure quality and prevent tokenism, the annex should be reviewed by an independent technical committee comprising experts in political science, public administration, and health policy before the proposal is submitted for final decision. Rather than creating unnecessary administrative complexity, such an approach could improve decision quality by ensuring that technical evidence is interpreted alongside political feasibility.

Establish a permanent political economy advisory unit

Institutional capacity is essential if PEA is to become a routine component of health governance rather than an occasional analytical exercise. For this reason, establishing a permanent Political Economy Advisory Unit within the Ministry of Health or the Secretariat of the Supreme Council of Health would represent an important institutional investment. Rather than serving as another administrative department, the unit should function as a strategic advisory body responsible for producing political economy assessments, monitoring stakeholder dynamics, identifying emerging implementation risks, and preserving institutional memory across successive administrations. Maintaining such expertise within government would reduce dependence on ad hoc external consultations while improving policy continuity despite changes in political leadership. To increase the feasibility of establishment and reduce bureaucratic resistance, the unit could initially be anchored within existing structures such as the Secretariat of the Supreme Council of Health or the Deputy for Planning at the Ministry of Health, thereby leveraging existing mandates and avoiding perceptions of creating redundant bureaucracy.

Build human capacity for PEA

Institutional reforms cannot succeed without individuals who possess the knowledge and skills necessary to implement them. At present, most health managers in Iran receive extensive training in medicine, public health, or health services management but relatively limited exposure to stakeholder analysis, institutional governance, negotiation, or political strategy. Consequently, capacity building should be regarded as a central component of institutionalizing PEA rather than a supplementary activity. Training initiatives could be tailored to different professional groups. Senior policymakers would benefit from executive programs emphasizing political leadership and strategic decision-making, while policy analysts, senior advisers, and mid-level managers could receive structured training in applied political economy analysis, focusing on stakeholder mapping, conflict negotiation, and institutional diagnostics. Long-term sustainability would also require integrating PEA into graduate curricula in public health, health policy, and health management, thereby preparing future generations of policymakers to routinely incorporate political and institutional considerations into health policy analysis.

Strengthen policy–research partnerships

A persistent challenge within Iran's health system is the limited interaction between academic research and practical policymaking. Although universities generate substantial health policy research, much of this evidence remains insufficiently connected to ongoing policy processes and implementation challenges. Strengthening long-term partnerships between academic institutions and health policymakers would help bridge this gap. Collaborative research agendas, researcher secondment programs within governmental organizations, joint policy dialogues, and funding mechanisms that prioritize politically informed implementation research would enable evidence generation to become more closely aligned with real policy needs. Such partnerships would also encourage continuous learning by ensuring that political experiences from previous reforms are systematically documented and incorporated into future decision-making.

Moving from recommendations to institutional change

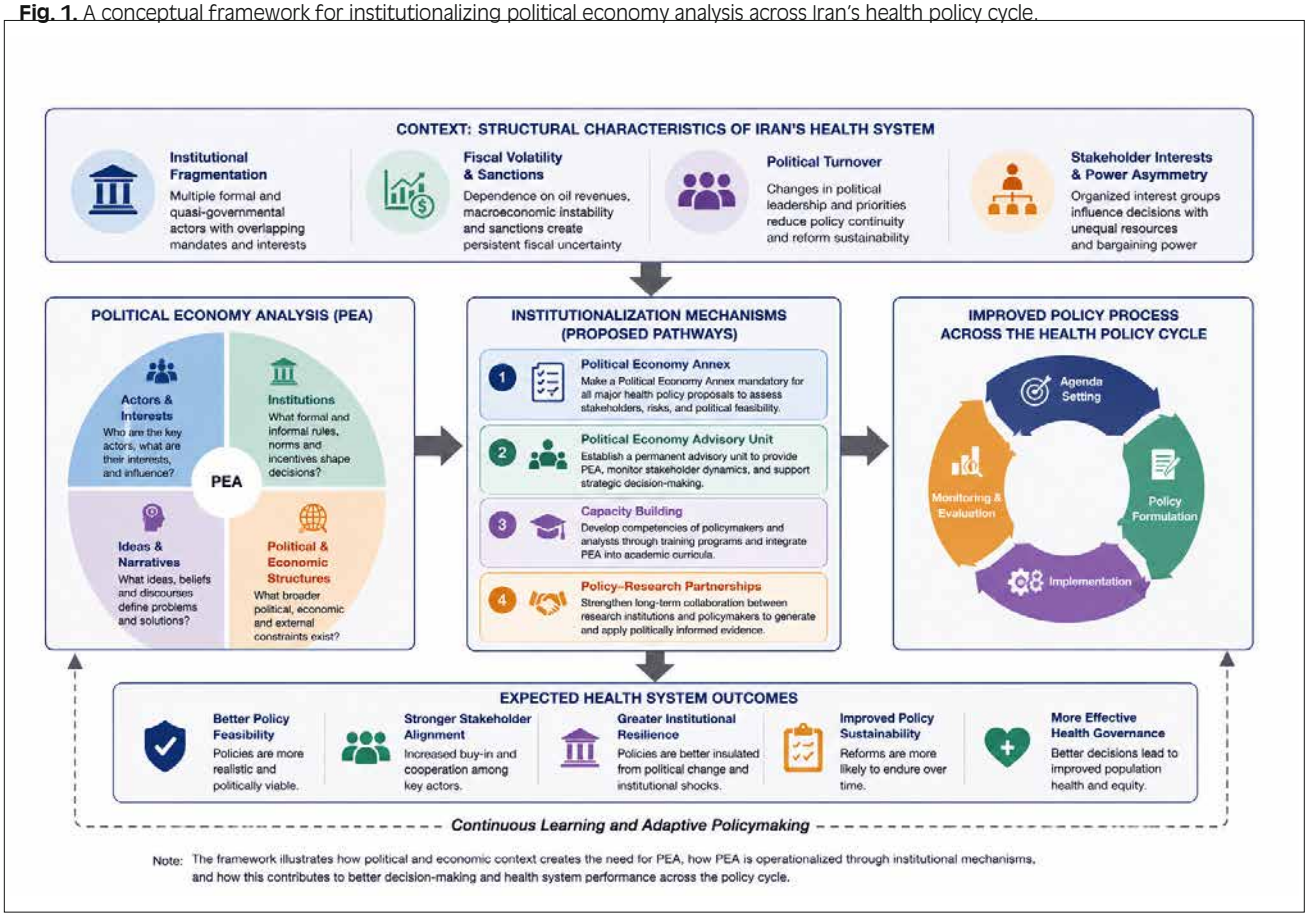
Implementing these reforms will inevitably encounter institutional resistance, competing organizational priorities, and resource limitations. However, these challenges reinforce rather than weaken the rationale for adopting political economy analysis, since they illustrate precisely the governance dynamics that PEA is designed to identify and address. Accordingly, institutionalization should be approached incrementally. Early efforts might focus on pilot implementation of the Political Economy Annex and targeted capacity-building initiatives before expanding toward permanent institutional arrangements and broader research partnerships. A phased strategy would allow policymakers to demonstrate early benefits, build stakeholder confidence, and generate the institutional support required for longer-term reform. As an initial concrete step, we recommend piloting the Political Economy Annex for one major upcoming reform, such as the revision of the national health insurance benefit package or the development of the next national health development plan, to demonstrate its value, generate actionable insights, and build momentum for broader institutional change. Ultimately, institutionalizing political economy analysis should not be understood as adding another bureaucratic requirement to health policymaking. Rather, it represents a shift toward a more comprehensive model of policy analysis in which technical evidence, institutional realities, and political feasibility are considered simultaneously. Such an approach is essential for improving the durability, legitimacy, and effectiveness of health reforms in Iran.

Figure 1 illustrates the conceptual framework proposed in this viewpoint. The framework demonstrates how the structural characteristics of Iran's health system, including institutional fragmentation, fiscal volatility, political turnover, and stakeholder power asymmetries, create the need for systematic PEA. PEA, operationalized through the assessment of actors, institutions, ideas, and political-economic structures, is translated into practice through four institutional mechanisms proposed in this article: a political economy annex for major policy proposals, a permanent political economy advisory unit, capacity-building initiatives, and policy–research partnerships. Collectively, these mechanisms strengthen decision-making throughout the health policy cycle and contribute to more feasible, resilient, and sustainable health policies.

Conclusion

This viewpoint has argued that many of the persistent challenges confronting Iran's health system cannot be adequately understood through technical analysis alone. Institutional fragmentation, fiscal uncertainty, political transitions, and stakeholder interests interact in ways that shape the feasibility, implementation, and sustainability of health reforms. PEA provides a systematic framework for understanding these interactions and complements conventional evidence-based policymaking by incorporating the political and institutional realities within which health policies are developed. Rather than viewing political economy analysis as an additional analytical exercise, it should be considered an essential component of health governance. Institutionalizing PEA through routine policy assessment, dedicated advisory structures, capacity-building initiatives, and stronger policy–research partnerships would improve the ability of policymakers to anticipate implementation challenges, manage competing interests, and enhance the long-term sustainability of health reforms. The recommendations proposed in this viewpoint are intended as practical and incremental steps rather than comprehensive institutional reforms. Their successful

Fig. 1. A conceptual framework for institutionalizing political economy analysis across Iran's health policy cycle.



implementation will inevitably depend on political commitment, organizational learning, and sustained collaboration among policymakers, researchers, and other stakeholders. Nevertheless, integrating political economy analysis into the health policy cycle represents an important opportunity to strengthen governance capacity and improve the effectiveness of future health reforms in Iran. Ultimately, strengthening health policy requires not only better and more relevant evidence but also a deeper understanding of the political and institutional contexts in which evidence is translated into action. Embedding political economy analysis within routine policymaking can help ensure that future reforms are not only technically sound but also politically feasible and institutionally sustainable. As a first step toward this vision, we recommend initiating a pilot application of the Political Economy Annex for a forthcoming major health policy decision – such as the revision of the national health insurance benefit package or the formulation of the next five-year health development plan, to generate practical experience, demonstrate value to decision-makers, and create momentum for sustainable institutional change.

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Consent for publication

Not applicable. This manuscript contains no individual person's data, images, or identifiable information. No consent for publication is required.

Availability of data and materials

Not applicable. This viewpoint article presents conceptual arguments and policy analysis based on previously published literature. All sources cited in this manuscript are publicly available in the academic literature and are referenced accordingly. No new datasets were generated or analyzed during this study.

Competing interest statement

The authors declare that they have no competing interests. No financial or non-financial conflicts of interest exist that could have influenced the content, analysis, or conclusions presented in this manuscript.

Authors' contributions

MM conceptualized the theoretical framework and critically revised the manuscript. MeB and AB contributed to the contextual analysis, developed practical pathways, and drafted the initial version. SA and AB contributed to the literature review and provided critical revisions. MaB supervised the project, contributed to conceptualization and design, and finalized the manuscript. All authors read and approved the final manuscript.

References

[1] Pollack Porter KM, Rutkow L, McGinty EE. The Importance of Policy Change for Addressing Public Health Problems. Public Health Rep 2018;133:9S-14S. https://doi.org/10.1177/0033354918788880.

[2] Babaita AO, Jahan Y, Nakamura R, Moriyama M. Identifying key factors for successful formulation and implementation of healthcare policies on non-communicable diseases: a multinational analysis. Front Public Health 2024;12:1292176. https://doi.org/10.3389/fpubh.2024.1292176.

[3] O'Brien GL, Sinnott SJ, Walshe V, Mulcahy M, Byrne S. Health policy triangle framework: Narrative review of the recent literature. Health Policy Open 2020;1:100016. https://doi.org/10.1016/j.hpopen.2020.100016.

[4] Moutselos K, Maglogiannis I. Evidence-based Public Health Policy Models Development and Evaluation using Big Data Analytics and Web Technologies. Med Arch 2020;74:47-53. https://doi.org/10.5455/medarh.2020.74.47-53.

[5] Song J, Zhu Z, Li Q, Chen Y, Wang Z, Zhou S, Xu M, Zheng ZJ. Comparative content analysis of national health policies, strategies and plans before and after COVID-19 among OECD and BRICS countries. Glob Health Res Policy 2025;10:6. https://doi.org/10.1186/s41256-024-00400-y.

[6] Behzadifar M, Ghanbari MK, Ravaghi H, Bakhtiari A, Shahabi S, Doshmangir L, Alidoost S, Azari S, Martini M, Ehsanzadeh SJ, Bragazzi NL. Health policy analysis in Eastern Mediterranean region using a health policy triangle framework: Historical and ethical insights from a systematic review. J Prev Med Hyg 2022;63:E351-E373. https://doi.org/10.15167/2421-4248/jpmh2022.63.2.2450.

[7] Cho V, Trowbridge J, Perreira T, Sodhi S, Karsan A, Hassan H, Perrier L, Prokopy M, Dale A, Brown A. Definition and key concepts of high-performing health systems: a scoping review. BMJ Open 2025;15:e094124. https://doi.org/10.1136/bmjopen-2024-094124.

[8] Moutselos K, Maglogiannis I. Evidence-based Public Health Policy Models Development and Evaluation using Big Data Analytics and Web Technologies. Med Arch 2020;74:47-53. https://doi.org/10.5455/medarh.2020.74.47-53.

[9] Breneol S, Curran JA, Marten R, Minocha K, Johnson C, Wong H, Langlois EV, Wozney L, Vélez CM, Cassidy C, Juvekar S, Rothfus M, Aziato L, Keeping-Burke L, Adjorlolo S, Patiño-Lugo DF. Strategies to adapt and implement health system guidelines and recommendations: a scoping review. Health Res Policy Syst 2022;20:64. https://doi.org/10.1186/s12961-022-00865-8.

[10] Ferreira DC, Vieira I, Pedro MI, Caldas P, Varela M. Patient Satisfaction with Healthcare Services and the Techniques Used for its Assessment: A Systematic Literature Review and a Bibliometric Analysis. Healthcare (Basel) 2023;11:639. https://doi.org/10.3390/healthcare11050639.

[11] Topp SM, Schaaf M, Sriram V, Scott K, Dalglish SL, Nelson EM, Sr R, Mishra A, Asthana S, Parashar R, Marten R, Costa JGQ, Sacks E, Br R, Reyes KAV, Singh S. Power analysis in health policy and systems research: a guide to research conceptualisation. BMJ Glob Health 2021;6:e007268. https://doi.org/10.1136/bmjgh-2021-007268.

[12] Sriram V, Keshri VR. Interest Groups and Health Facility Regulation - Future Directions for Health Policy and Systems Research Comment on "What Lies Behind Successful Regulation? A Qualitative Evaluation of Pilot Implementation of Kenya's Health Facility Inspection Reforms". Int J Health Policy Manag 2023;12:7826. https://doi.org/10.34172/ijhpm.2023.7826.

[13] Koon AD, Rao KD, Tran NT, Ghaffar A. Embedding health policy and systems research into decision-making processes in low- and middle-income countries. Health Res Policy Syst 2013;11:30. https://doi.org/10.1186/1478-4505-11-30.

[14] Shearer JC, Abelson J, Kouyaté B, Lavis JN, Walt G. Why do policies change? Institutions, interests, ideas and networks in three cases of policy reform. Health Policy Plan 2016;31:1200-11. https://doi.org/10.1093/heapol/czw052.

[15] Singh PK, Singh S, Ahmad S, Singh VK, Kumar R. Navigating power dynamics and hierarchies in medical education: Enhancing faculty experiences and institutional culture. J Postgrad Med 2025;71:82-90. https://doi.org/10.4103/jpgm.jpgm_728_24.

[16] Berdida DJE. Valuing Invisible Labor: A Feminist Political Economy Analysis of the Cost and Burden of Critical Care Nursing in Low- and Lower-Middle-Income Countries. Nurs Inq 2026;33:e70097. https://doi.org/10.1111/nin.70097.

[17] Nzinga J, Olwanda E, Opondo K, Kimutai H, Cooper J, Arwah B, Tsofa B, Barasa E, Croke K. Power, interests, and maternal health care: a political economy analysis of service delivery redesign in Kenya. Health Policy Plan 2026;41:558-69. https://doi.org/10.1093/heapol/czaf111.

[18] Zakumumpa H, Paina L, Ssegujja E, Ssempala R, Ssengooba F. Barriers to raising taxes on tobacco products in Uganda: a political economy analysis. Health Policy Plan 2026;41:225-36. https://doi.org/10.1093/heapol/czaf098.

[19] Witter S, Bertone MP, Baral S, Gautam G, Pratap SKC, Pholpark A, Saputri NS, Darmawan AB, Toyamah N, Fillaili R, de Oliveira Cruz V, Sparkes S. Political economy analysis of health financing reforms in times of crisis: findings from three case studies in south-east Asia. Int J Equity Health 2025;24:34. https://doi.org/10.1186/s12939-025-02395-5.

[20] Sing F, Mackay S, Swinburn B, Garton K. A political economy analysis of the legislative response to unhealthy food and beverage marketing in Chile, Canada and the UK. Global Health. 2025;21:4. https://doi.org/10.1186/s12992-024-01093-1.

[21] Kebede MA, Beyene AD, Ifeanyichi M, Bognini M, Takele M, Hargest R, Friebel R. Political economy analysis of Ethiopia's Integrated Emergency Surgical Officer programme. Br J Surg 2025;112:xv41-xv42. https://doi.org/10.1093/bjs/znaf220.

[22] Johnson E, Jusril H, Pratiwi L, Trisnasari S, Thow AM, Rachmi CN. Looking towards the sweet, sweet future: a political economy analysis of sugar and nutrition policy in Indonesia. Public Health Nutr 2025;28:e112. https://doi.org/10.1017/S1368980025100566.

[23] Engdawork K, D'Ambruoso L, Hailu T, Yared M, Geletu GM, Baraki SG, Sebsibe E, Abbott P. "Space to see the future"? A political economy analysis of child and adolescent mental health and well-being in Ethiopia including routes for change. Front Sociol 2025;9:1488619. https://doi.org/10.3389/fsoc.2024.1488619.

[24] Chukwuma JN, Obi FA. A political economy analysis of health policymaking in Nigeria: the genesis of the 2014 National Health Act. Health Policy Plan 2025;40:459-70. https://doi.org/10.1093/heapol/czaf007.

[25] Garcia PJ, Kitutu FE, Guzman JM, Najarro L, Ssengooba F, King C. Challenges in the medical oxygen ecosystem of Peru: A political economy analysis. PLOS Glob Public Health 2025;5:e0005667. https://doi.org/10.1371/journal.pgph.0005667.

[26] Karuveettil V, Janakiram C, John D, Mathur M, Varma B, Green H. Political economy analysis of health: a scoping review protocol. JBI Evid Synth 2024;22:1906-13. https://doi.org/10.11124/JBIES-23-00204.

[27] Abdullahi LH, Oketch S, Komen H, Mbithi I, Millington K, Mulupi S, Chakaya J, Zulu EM. Gendered gaps to tuberculosis prevention and care in Kenya: a political economy analysis study. BMJ Open 2024;14:e077989. https://doi.org/10.1136/bmjopen-2023-077989.

[28] Ahsan A, Amalia N, Rahmayanti KP, Adani N, Wiyono NH, Endawansa A, Utami MG, Miranti Yuniar A, Anastasia EV, Pertiwi YBA. Political economy analysis of health taxes (tobacco, alcohol drink and sugar-sweteened beverage): qualitative study of three provinces in Indonesia. BMJ Open 2024;14:e085863.

[29] Elliott LM, Waqa GD, Ravuvu ALA, Dalglish SL, Topp SM. Watered down: a cross-case political economy analysis of sugar-sweetened beverage taxes in Vanuatu and Fiji. Health Promot Int 2024;39:daae142. https://doi.org/10.1093/heapro/daae142.

[30] Thow AM, Neves D, Aidoo R, Aduku LNE, Moyo B, Apprey C, Kroll F, Annan R. Strengthening the governance of food systems for nutrition in Africa: a political economy analysis of food policy in South Africa and Ghana. Public Health Nutr 2024;27:e243. https://doi.org/10.1017/S1368980024001356.

[31] Panwar V, Wilkinson E, Pelling M. The barriers to uptake of disaster risk management science in urban planning: A political economy analysis. Disasters 2024;48:e12644. https://doi.org/10.1111/disa.12644.

[32] Bigirinama RN, Mothupi MC, Mwene-Batu PL, Kozuki N, Chiribagula CZ, Chimanuka CM, Ngaboyeka GA, Bisimwa GB. Prioritization of maternal and newborn health policies and their implementation in the eastern conflict affected areas of the Democratic Republic of Congo: a political economy analysis. Health Res Policy Syst 2024;22:55. https://doi.org/10.1186/s12961-024-01138-2.

[33] Engdawork K, D'Ambruoso L, Hailu T, Yared M, Geletu GM, Baraki SG, Sebsibe E, Abbott P. "Space to see the future"? A political economy analysis of child and adolescent mental health and well-being in Ethiopia including routes for change. Front Sociol 2025;9:1488619. https://doi.org/10.3389/fsoc.2024.1488619.

[34] Kuwawenaruwa A, Mollel H, Machonchoryo JM, Margini F, Jaribu J, Binyaruka P. A political economy analysis of strengthening health information system in Tanzania. BMC Med Inform Decis Mak 2023;23:245. https://doi.org/10.1186/s12911-023-02319-9.

[35] Rodríguez DC, Balaji LN, Chamdimba E, Kafumba J, Koon AD, Mazalale J, Mkombe D, Munywoki J, Mwase-Vuma T, Namakula J, Nambiar B, Neel AH, Nsabagasani X, Paina L, Rogers B, Tsoka M, Waweru E, Munthali A, Ssengooba F, Tsofa B. Political economy analysis of subnational health management in Kenya, Malawi and Uganda. Health Policy Plan 2023;38:631-47. https://doi.org/10.1093/heapol/czad021.

[36] Nannini M, Biggeri M, Putoto G. Comparative Insights to Advance Political Economy Analysis: A Response to Recent Commentaries. Int J Health Policy Manag 2023;12:8367. https://doi.org/10.34172/ijhpm.2023.8367.

[37] Tsofa B, Waweru E, Munywoki J, Soe K, Rodriguez DC, Koon AD. Political economy analysis of sub-national health sector planning and budgeting: A case study of three counties in Kenya. PLOS Glob Public Health 2023;3:e0001401. https://doi.org/10.1371/journal.pgph.0001401.

[38] Behzadifar M, Bragazzi NL, Arab-Zozani M, Bakhtiari A, Behzadifar M, Beyranvand T, Yousefzadeh N, Azari S, Sajadi HS, Saki M, Saran M, Gorji HA. The challenges of implementation of clinical governance in Iran: a meta-synthesis of qualitative studies. Health Res Policy Syst. 2019;17:3. https://doi.org/10.1186/s12961-018-0399-5.

[39] Lotfian A, Moghri J. Structural challenges and strategic responses in Iran's COVID-19 management: insights from healthcare experts. BMC Public Health 2026;26:1434. https://doi.org/10.1186/s12889-026-26860-0.

[40] Jalilvand MA, Raeisi AR, Shaarbafchizadeh N. Hospital governance accountability challenges in Iran: a qualitative study. BMC Health Serv Res 2025;25:946. https://doi.org/10.1186/s12913-025-13100-1.

[41] Hedayati M, Masoudi Asl I, Maleki M, Fazaeli AA, Goharinezhad S. Policy analysis of the protection of Iranian households against catastrophic health expenditures: a qualitative analysis. BMC Health Serv Res 2023;23:445. https://doi.org/10.1186/s12913-023-09275-0.

[42] Aboulhallaj M, Mousavi SM, Jafari M, Vosoogh-Moghaddam A, Bahariniya S, Ghasemyani S, Tabatabaei Far SS. Challenges and executive requirements of advanced health system governance based on general health policies in Iran: qualitative research. BMC Health Serv Res 2024;24:1517. https://doi.org/10.1186/s12913-024-11887-z.

[43] Yazdizadeh B, Sajadi HS, Mohtasham F, Mohseni M, Majdzadeh R. Systematic review and policy dialogue to determine challenges in evidence-informed health policy-making: findings of the SASHA study. Health Res Policy Syst 2021;19:73. https://doi.org/10.1186/s12961-021-00717-x.

[44] Mahdiyan S, Amini-Rarani M, Rezayatmand R, Shaarbafchizadeh N. Understanding challenges of primary healthcare financial resource allocation in Iran. Health Res Policy Syst 2025;23:82. https://doi.org/10.1186/s12961-025-01331-x.

[45] Khodayari-Zarnaq R, Mobasseri K, Ghasemyani S, Sadeghi-Ghyassi F, Naghshi M, Kabiri N. Challenges and Weaknesses of Leadership and Governance-related Health Policies in Iran: A Systematic Review. Arch Iran Med 2024;2:508-21. https://doi.org/10.34172/aim.28907. Epub 2024 Sep 1. PMID: 39465526;

[46] Khodayari-Zarnaq R, Mobasseri K, Ghasemyani S, Sadeghi-Ghyassi F, Naghshi M, Kabiri N. Challenges and Weaknesses of Leadership and Governance-related Health Policies in Iran: A Systematic Review. Arch Iran Med 2024;27:508-21. https://doi.org/10.34172/aim.28907.

[47] Asadi-Lari M, Ahmadi Teymourlouy A, Maleki M, Eslambolchi L, Afshari M. Challenges and opportunities for Iranian global health diplomacy: lessons learned from action for prevention and control of noncommunicable diseases. Health Res Policy

Syst. 2021 Dec 24;19(1):152. https://doi.org/10.1186/s12961-021-00800-3.

[48] Keyvani H, Majdzadeh R, Hanaee J, Doshmangir L. Determinants and policy approaches to healthcare professional retention in Iran: A mix of scoping review and qualitative evidence. PLoS One 2026;21:e0339855. https://doi.org/10.1371/journal.pone.0339855.

[49] Keyvani H, Majdzadeh R, Hanaee J, Doshmangir L. Determinants and policy approaches to healthcare professional retention in Iran: A mix of scoping review and qualitative evidence. PLoS One 2026;21:e0339855. https://doi.org/10.1371/journal.pone.0339855.

[50] Eskandarian M, Raeisi A, Ferdosi M, Golzari M. Toward Iran's health system regionalization: A qualitative approach. J Educ Health Promot 2025;14:380. https://doi.org/10.4103/jehp.jehp_825_24.

[51] Beiranvand S, Saki M, Behzadifar M, Bakhtiari A, Behzadifar M, Keshvari M, Bragazzi NL. The effect of the Iranian health transformation plan on hospitalization rate: insights from an interrupted time series analysis. BMC Health Serv Res 2020;20:327. https://doi.org/10.1186/s12913-020-05186-6.

[52] Darvishi B, Behzadifar M, Ghanbari MK, Ehsanzadeh SJ, Bakhtiari A, Behzadifar M, Azari S, Bragazzi NL. Financial Protection Indexes and the Iranian Health Transformation Plan: A Systematic Review. Yale J Biol Med 2021;94:465-76.

[53] Moeeni M, Nosratnejad S, Rostampour M, Ponnet K. To what extent has the Iranian Health Transformation Plan addressed inequality in healthcare financing in Iran? Int J Equity Health 2023;22:62. https://doi.org/10.1186/s12939-023-01880-z.

[54] Laurisz N, Ćwiklicki M, Żabiński M, Canestrino R, Magliocca P. The Stakeholders' Involvement in Healthcare 4.0 Services Provision: The Perspective of Co-Creation. Int J Environ Res Public Health 2023;20:2416. https://doi.org/10.3390/ijerph20032416.

[55] Loh YSL, Koh SGM, Siah AKL, Cheong WL, Su TT. Stakeholder engagement and pharmaceutical pricing regulation: a qualitative inquiry. J Pharm Policy Pract 2025;18:2550370. https://doi.org/10.1080/20523211.2025.2550370.

[56] Rizk HI, Elkholy MM, Barakat AA, Elsayed RMM, Abd El Fatah SAM. Perspectives of pharmaceutical stakeholders on determinants of medicines accessibility at the primary care level. J Egypt Public Health Assoc 2021;96:1. https://doi.org/10.1186/s42506-020-00062-x.

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History of medicine and ethics

Onofrio Scassi (1768-1836) and the dissemination of smallpox vaccination practices in the Ligurian Republic (1797-1805) and during the Napoleonic Empire (1805-1814)

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Keywords

Onofrio Scassi • Smallpox vaccination • Ligurian republic • Napoleonic Empire • History of vaccine • History of public health and hygiene

Summary

For centuries, humans sought to contain the devastating effects of smallpox. Indeed, as early as the 2nd century BC, a method called "variolation" was utilised to combat the disease. It was not until 1798, however, that the English physician and naturalist Edward Jenner invented a more effective technique of immunization, which he called vaccination. Among the various personalities who strove to spread Jenner's sensational innovation throughout Italy, the Ligurian doctor Onofrio Scassi played a prominent role. Onofrio Scassi (1768-1836) studied medicine in Genoa, graduating in 1788. He subsequently developed his skills further at the University of Pavia and in the United Kingdom. Upon returning to Genoa, in addition to holding various public offices, he was among the first to practise smallpox vaccination in Italy.
Moreover, in 1801, he was one of the founders of the Medical Society of Emulation, which worked for years to spread the practice of vaccination between the period of the Ligurian Republic (1797-1805) and the years in which Genoa was part of Napoleon's French empire (1805-1814).

Background

For many centuries, smallpox posed one of the most serious threats to human health. Caused by a virus belonging to the Variola family, this highly contagious infectious disease was originally widespread in Asia, Africa and Europe, from where it later spread to the Americas and the rest of the world (causing high mortality among native peoples, who lacked antibodies against the disease) [1].
Its devastating impact stemmed not only from its rapid spread but also from the severity of its symptoms and the high mortality rate associated with infection.
Smallpox initially manifested itself through high fever and headache; subsequently, within 12-15 days, pustular rashes developed all over the body. The disease was fatal in 50% of cases and often left survivors with permanent disfiguring scars (and, in some extreme cases, caused blindness) [2].
Given these devastating consequences, communities across different regions sought ways to prevent or mitigate the effects of the disease, despite their limited medical knowledge.
Over the years, to counteract the terrible and potentially lethal effects of this disease, people tried to limit its impact by implementing the scant knowledge of hygiene and health at their disposal.
The earliest preventive practice developed, known as "variolation", had been used for centuries in Asia and parts of Africa. The technique consisted of deliberately exposing healthy individuals to material obtained from smallpox lesions in order to induce a mild infection and confer immunity. Despite the risks associated with the procedure, variolation significantly reduced mortality compared with naturally acquired smallpox and constituted an important precursor to modern vaccination [3].
In particular, this practice involved inoculating a healthy patient with material taken from the pustules of a patient infected with a mild form of smallpox (*Variola minor*).
In this way, the less dangerous form of smallpox was deliberately caused in the healthy patient, thus making him immune to the most lethal form, too.
For a long time, this technique remained the only method of preventing the disastrous and lethal effects of smallpox, and was, indeed, fairly efficacious (though it made the "variolized" patient a vehicle for the spread of the disease and also exposed him to the risk of contracting other diseases, such as tuberculosis or syphilis, as well as developing bacterial infections) [4].

Introduction

The first news regarding the practice of variolation reached Europe at the beginning of the 18th century [5] through the reports of some doctors who had visited Istanbul. These included Emanuel Timoni (1669-1720)

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and Giacomo Pilarino (1659-1718) [4].

- **Emanuel Timoni** was a Greek physician from Constantinople who played a significant role in introducing variolation to Western Europe. He studied medicine at the University of Padua and later worked in the Ottoman Empire, where he became familiar with the local practice of smallpox inoculation. Like Giacomo Pilarino, he observed that variolation involved inducing a mild form of the disease in order to provide protection against more severe infection [6].
- **Giacomo Pilarino,** was a physician trained; he was a notable early European advocate of variolation; while working in the Ottoman Empire, he became familiar with the practice of variolation and later helped introduce it to Europe. In 1715, he published a treatise describing the method and supporting its use as a preventive measure against smallpox, contributing to its gradual acceptance among European physicians.

It was, however, the determination of a woman, Lady Mary Wortley Montague, that actually brought this practice to the attention of European medicine, subsequently enabling it to spread throughout Europe.

Nevertheless, the practice was short-lived in Europe. Indeed, less than 80 years after its introduction and diffusion across the continent (the technique being adopted at various royal courts, such as those of France, Prussia and Austria, for example), it was superseded by a more effective method of immunization – designed in 1796 by the English physician and naturalist Edward Jenner (1749-1823) (Fig. 1). Jenner's method of immunization, which he called 'vaccination', involved inoculating a healthy patient with secretions from animals or humans affected by cowpox, a mild disease related to smallpox.

In this way, the patient would also develop immunity to the much more dangerous and lethal form of human smallpox.

Today, however, we know that Jenner was not actually the first person to use vaccine material to immunize patients against smallpox. Indeed, many English doctors living in cattle-rearing areas were already familiar with this method. Jenner, however, had the undisputed merit of conferring scientific status on the practice of vaccination by demonstrating empirically that the technique elicited immunity to smallpox [7].

Moreover, he spread knowledge of his method systematically through the publication, at his own expense, of his pamphlet *An Inquiry into the Causes and Effects of the Variolae Vaccinae, a disease discovered in some of the western of England, particularly Gloucestershire and Known by the Name of Cow Pox* in 1798 [8].

Jenner's innovative method soon spread from England throughout Europe, including Italy. The adoption of vaccination in Italy was due partly to individual efforts (by far-sighted doctors eager to leave their mark on the history of medicine) and partly to collective undertakings (as a result of international scientific collaboration established by some Italian medical circles) [9].

Among the most emblematic personalities involved in the diffusion of Jenner's method in Italy were:

- Luigi Sacco (1769-1836), the first doctor to use vaccine material gathered in Italy [10];
- Michele Troja (1747-1827), Antonio Miglietta (1767-1826), Domenico Cotugno (1736-1822) and Gennaro Galbiati (1766-1844), who were among the first doctors to introduce vaccination into the Kingdom of Naples [11, 12];
- Giacomo Barzellotti, one of the first advocates of smallpox vaccination in the Grand Duchy of Tuscany [13];
- Pietro Moscati (1739-1824), who, having already been a fervent supporter of variolation, tried to spread the practice of smallpox vaccination in Milan and Lombardy [14, 15];
- the Ligurian doctor Onofrio Scassi (1768-1836), who was the first to spread vaccination in Liguria (and perhaps the first to practise it in Italy) [16].

Onofrio Scassi, the son of a doctor, Agostino Scassi, was born in Cogoleto (Genoa) in 1768 (Fig. 2) [17]. He studied medicine in Genoa, graduating in about 1788. He then attended at the University of Pavia the lectures of the doctor and hygienist Johann Peter Frank (1745-1821), considered by many to be the founder of modern public health, and those of the doctor, surgeon and anatomist Antonio Scarpa (1752-1832), remembered for his studies on aneurism, on congenital clubfoot and on hernias.

His decision to pursue his studies at the University of

Fig. 1. This is a famous portrait of Edward Jenner painted by John Raphael Smith. In the background, the English countryside is depicted with several cows grazing near a farmwoman – both of them the most important figures in Jenner's discovery of the smallpox vaccination.

Fig. 2. This is one of the few potrait available of Onofrio Scassi. It's a XIX century engraving that depicts the famous Ligurian physician at work in his study. From: itale V. Onofrio Scassi e la vita genovese del suo tempo (1768-1836): con appendice su Raffaele Scassi. Società Ligure di Storia Patria: Genova 1932.

Pavia was by no means casual. Indeed, the University of Pavia was one of the liveliest cultural centres of the time, boasting among its professors, in addition to the above-mentioned Scarpa and Frank, also Lazzaro Spallanzani (1729-1799) and Alessandro Volta (1745-1827) [18].

After his study period in Pavia, the young Ligurian doctor decided, probably on the advice of William Batt (a doctor of English origin who had lived in Genoa since 1771), to go to England and then to Scotland in order to perfect his studies.

It was in Edinburgh in particular that Scassi received his greatest recognition, being enrolled in the Royal Medical Society and publishing (in 1792) one of his first important works: *De foetu humano. Dissertatio anatomica-physiologica acutore Onuphrio Agnese Scassi, Genuensi, philosophie et medicinae doctore, Regiae Societatis Medicae Edim. Membro* [19].

Having returned to Genoa in 1794, he was (thanks to the fame he had acquired abroad) registered with the College of Physicians and was charged by the genoese sanitation office with monitoring and containing an epidemic that had broken out in western Liguria (between Savona and Ventimiglia).

With the fall of the Genoese Republic in June 1797, Scassi promptly joined the newly formed Ligurian Republic, obtaining the command of a company of the national guard. On the occasion of the legislative elections (the only case of elections held in the whole of Italy in that period), he was selected to compose the body of second-degree electors.

The following year, when he had already been appointed to the chair of theoretical medicine at Pammatone Hospital, Scassi began to assume an increasingly political role – in addition to his scientific one – which saw him become president of the College of Physicians and a member of the National Institute.

It was precisely within this prestigious body that Scassi presented the government a project for the reform of studies, which, however, was not implemented [20].

Indeed, precisely at that historical juncture, the Ligurian Republic was going through the most critical phase of its brief existence; in 1799, it bore the brunt of a counteroffensive by the powers of the first anti-Napoleonic coalition, which besieged Genoa for a long time (bringing famine and epidemics to the city) and temporarily conquered it in 1800 [21-23].

Paradoxically, it was precisely during that terrible period in the life of the Ligurian Republic that Scassi, thanks to the help of his colleague Batt, was able to contact the famous Geneva doctor Louis Odier (1747-1817) in order to obtain some vials of vaccine pus and put into practice Jenner's sensational technique of vaccination.

Although the first news of this innovative method of vaccination had reached the ears of Scassi and Batt immediately after the publication of Jenner's pamphlet, it was only later, in the autumn of 1800, that Scassi managed to carry out the first smallpox vaccinations.

In that same autumn, the doctor Luigi Sacco first succeeded in using vaccine material gathered in Italy, thereby obviating the long waiting times required to obtain vaccine pus from northern European countries.

Scassi's first experience as a vaccinator prompted him to publish a short pamphlet the following year, in which he reflected on the methods of inoculation and the potential critical issues of the practice [24]. On one hand, thanks to the discovery by Sacco, vaccinations in Italy were able to avoid the long waiting times for vaccines pus coming from abroad. On the other hand, thanks to the pamphlet published by Scassi, the technique for vaccinating was explained in the finest detail to all Italian doctors eager to put it on practice.

In the wake of this public commitment, which probably stemmed from the ideas of Johan Peter Frank (according to whom health was a collective good which had to be protected by the State) [25], Scassi, together with several other doctors and personalities from the Genoese healthcare environment (including William Batt, Luigi Marchelli, the Mojon brothers, Antonio Mongiardini and Domenico Viviani) actively participated in the founding of the Genoa Medical Society of Emulation in July 1801.

The task of the newly established Society was simple: to constitute a meeting point for the various personalities involved in the health field, in order to "share their insights

Fig. 3. Plan of the city of Genoa made at the beginning of the XIX century. This figure shows the ancient fortification of the city and the inhabited centers of the surrounding valleys.

and the successful results of their observations" and, furthermore, to spread the practice of vaccination throughout Liguria [26]. The Medical Society remained active for the last years of the Republic (1801-1805) and for the entire period in which Genoa and Liguria were an integral part of Napoleon Bonaparte's Empire (1805-1814), promoting the publication of various scientific pamphlets, including those concerning smallpox vaccination, and collaborating in the immunization of the Genoese population (Fig. 3) [27].

As in other parts of Italy, however, the vaccination campaign animated by the various members of the Society, especially Luigi Marchelli [28] and William Batt [29-31], only moved beyond the experimental phase during the Napoleonic era, through the intervention of the Central Vaccination Committees established by order of the French government in every department of the Empire. Although the vaccination policies applied in the French Empire and in the Kingdom of Italy have been studied quite in depth, a detailed study is still missing on the practices, policies and results that these had in the Ligurian territory.

Onofrio Scassi during the Kingdom of Sardinia

After holding various public offices, both in the Ligurian Republic (of which he also became a senator in 1804) and in the French Empire, Scassi also managed to carve out important public roles for himself within the subsequent institutional structure that the city of Genoa (along with the whole of Liguria) assumed in 1815 on the occasion of its annexation to the Kingdom of Sardinia [32].

Having recognized Scassi's great merits in the scientific and administrative fields, the new ruling dynasty appointed him Honorary Physician of the Royal House of Savoy (1815), and conferred upon him the title of Count of the Kingdom (1825) and, subsequently, the title of Knight of Saints Maurice and Lazarus, one of the oldest order of knighthood in the world (1831).

Conclusion

The development of smallpox vaccination in Liguria represents an important example of the change of a pioneering medical innovation into an increasingly organized and institutionalized public health intervention. The experience of the Ligurian Republic and the subsequent Napoleonic administration offers a compelling example of how the successful implementation of preventive measures depended not only on scientific advances but also on the establishment of administrative structures capable of coordinating health policies, mobilizing local authorities, and fostering public trust in vaccination practices. Within this context, physicians such as Luigi Marchelli, William Batt, and, above all, Onofrio Scassi played a pivotal role in translating Jennerian vaccination from a promising scientific discovery into a practical and widely disseminated instrument of disease prevention. Their activities contributed to the creation of a network linking medical expertise, civic institutions, and political authorities, thereby facilitating the acceptance and

diffusion of vaccination among the population. The case of Scassi is particularly emblematic for the close relationship that emerged between medicine, public administration, and social responsibility during the early nineteenth century. Throughout his career, including his service as Mayor of Genoa between 1830 and 1834, he remained actively committed to the promotion of smallpox vaccination, continuing this work until his death in 1836. His long-standing dedication reflects the growing awareness, among physicians and policymakers alike, of the collective value of preventive medicine and population-based health intervention More broadly, the historical experience examined in this study demonstrates that many of the principles now regarded as essential foundations of modern public health were already emerging during the formative decades of vaccination practice. The gradual development of immunization programs was not simply a medical achievement but also a complex social, institutional, and cultural process that required the integration of scientific knowledge, governmental commitment, effective communication strategies, and active public participation. These elements, which continue to define successful public health interventions today, were already evident in the efforts of early vaccination advocates who sought to promote acceptance of vaccination and expand its reach among diverse populations.

In this context, revisiting the contributions of pioneers such as Scassi provides more than a historical reconstruction of early vaccination campaigns. His work illustrates how the success of preventive medicine has always depended on the ability to translate scientific evidence into practical policies, to build public trust in health authorities, and to foster collaboration between medical professionals, local institutions, and communities. By examining the challenges he faced – including resistance to vaccination, implementation challenges, and the need for public education – we gain valuable insight into the enduring dynamics that continue to shape vaccination programs worldwide. Furthermore, the historical perspective offered by figures like Scassi helps highlight the historical roots of contemporary public health challenges. Present-day concerns surrounding vaccine hesitancy, misinformation, public confidence in scientific expertise, and equitable access to preventive healthcare are not entirely new phenomena; rather, they represent modern manifestations of issues that have accompanied vaccination efforts since their inception. Understanding how these challenges were addressed in earlier periods can therefore provide useful lessons for designing more effective vaccination policies and communication strategies in the present day.

The enduring relevance of these pioneers lies not only in their historical achievements but also in the insights their experiences provide for present-day public health practice. Their experiences demonstrate that the effectiveness and legitimacy of public health systems are the result of long-term processes involving scientific innovation, political support, and societal engagement.

By highlighting the enduring interplay between scientific innovation, institutional action, and community engagement, this legacy provides an interpretative framework for contemporary public health practice and the development of global vaccination strategies, suggesting that the control of infectious diseases in an increasingly interconnected world may depend on the sustained integration of scientific knowledge, governance capacity, and collective engagement [33].

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The authors declare that the research was conducted in the absence of any commercial or financial relationship that could be construed as a potential conflict of interest.

Authors' contributions

EB: conceived the study. EB, MM: designed the study; drafted the manuscript; performed a search of the literature; revised the manuscript; conceptualization and methodology; investigation and data curation; original draft preparation; review; editing.

All authors have read and approved the latest version of the paper for publication.

References

[1] Forni D, Molteni C, Cagliani R, Clerici M, Sironi M. Analysis of variola virus molecular evolution suggests an old origin of the virus consistent with historical records. Microb Genom 2023;9:mgen000932. https://doi.org/10.1099/mgen.0.000932.

[2] La Placa M. Principi di microbiologia medica. V edn. Bologna; Esculapio ed.1988.

[3] World Health Organization. Available at: https://www.who.int/news-room/spotlight/history-of-vaccination/history-of-smallpox-vaccination. Accessed on: 05/06/2026.

[4] Riedel S. Edward Jenner and the history of smallpox and vaccination. Proc (Bayl Univ Med Cent) 2005;18:21-5. https://doi.org/10.1080/08998280.2005.11928028.

[5] Orsini D, Martini M. From inoculation to vaccination: the fight against smallpox in Siena in the 18th and 19th centuries. Infez Med 2020;28:634-41.

[6] Kyrkoudis T, Tsoucalas G, Thomaidis V, Bakirtzis I, Nalbandi E, Polychronidis A, Fiska A. Vaccination of the Ethnic Greeks (Rums) Against Smallpox in the Ottoman Empire: Emmanuel

Timonis and Jacobus Pylarinos as Precursors of Edward Jenner. Erciyes Med J 2021;43:100-6. https://doi.org/10.14744/etd.2020.82856.

[7] Martini M, Behzadifar M, Bragazzi NL, Orsini D Poc (Pox), a term for various infectious diseases in the history of public health and epidemiology: the dreaded Smallpox, the almost unknown Alastrim and the Mpox. J Prev Med Hyg 2023;64:E209-E14. https://doi.org/10.15167/2421-4248/jpmh2023.64.2.3011.

[8] Jenner E. An Inquiry into the causes and effects of the Variolae Vaccinae, a disease discovered in some of the western counties (qui ho corretto "countries" con "counties") of England, particularly Gloucestershire and known by the name of Cow Pox. Londra 1798.

[9] Omes M.E. Storia della vaccinazione antivaiolosa in Italia. Da Napoleone all'Unità. Roma 2025.

[10] Armocida G, Licata M, Martini M. I pionieri italiani del metodo jenneriano Onofrio Scassi e Luigi Sacco. L'influenza dell'Omelia del Vescovo di Goldstat nelle campagne di vaccinazione antivaiolosa nel Meridione d'Italia. L'Idomeneo 2014;17:175-86. https://doi.org/10.1285/i20380313v17p175

[11] Tisci C. Lo scudo contro il Vaiolo. Antonio Miglietta e la profilassi nel Regno di Napoli (1801-1826). Lecce: Edizioni Grifo 2015.

[12] Martini M, Bifulco M, Orsini D. Smallpox vaccination and vaccine hesitancy in the Kingdom of the Two Sicilies (1801) and the great modernity of Ferdinand IV of Bourbon: a glimpse of the past in the era of the SARS-COV-2 (COVID-19) pandemic. Public Health 2022;213:47-53. https://doi.org/10.1016/j.puhe.2022.09.012.

[13] Vigni L. La diffusione della vaccinazione contro il vaiolo. Il caso di Siena in eta napoleonica [Smallpox vaccination in Siena during the Napoleonic era]. Infez Med 2001;9:115-8.

[14] Aldini NN, Pontoni L, Scarani P, Ruggeri A. Documenti ed immagini sull' innesto del vaiuolo vaccino in Bologna al principio del XIX secolo [Documents and figures about the vaccine in Bologna at the beginning of the nineteenth century]. Med Secoli 2007;19:195-208.

[15] Ferraro G. Vita ed opere del grande vaccinatore italiano Dottore Luigi Sacco e sunto storico dello innesto del vaccino e della rivaccinazione. Milano: Francesco Sanvito 1858.

[16] Vitale V. Onofrio Scassi e la vita genovese del suo tempo (1768-1836): con appendice su Raffaele Scassi. Società Ligure di Storia Patria: Genova 1932.

[17] De Francesco A, a cura di, voce "Onofrio Scassi" nel Dizionario Biografico degli Italiani 2018;91. link: https://www.treccani.it/enciclopedia/onofrio-scassi_(Dizionario-Biografico)/. Accessed on: 05/06/2026.

[18] Storia dell'Università di Pavia: Available at: https://museoperlastoria.unipv.it/. Accessed on: 05/06/2026.

[19] Scassi O. De foetu humano. Dissertatio anatomica-physiologica acutore Onuphrio Agnese Scassi, Genuensi, philosophie et medicinae doctore, Regiae Societatis Medicae Edim. Membro, T. Ruddimanni ed., Edimburgo 1792.

[20] Scassi O. Piano dettagliato di Pubblica Istruzione presentato dall'Instituto Nazionale al Corpo Legislativo della Repubblica Ligure a' 3 dicembre 1798, anno II della R.L. Genova: Stamperia dell'Instituto Nazionale 1798.

[21] Tonizzi ME. Genova nell'Ottocento. Da Napoleone all'Unità (1805-1861). Genova: Rubbettino 2013.

[22] Ronco A. Storia della Repubblica Ligure 1797-1799. Genova: SAGEP 1986.

[23] Assereto G. La seconda repubblica Ligure (1800-1805). Dal "18 brumaio genovese" all'annessione alla Francia. Milano: Selene edizioni 2000.

[24] Scassi O. Riflessioni sulla vaccina lette all'Instituto Nazionale. Genova 1801.

[25] Parma AJP. Frank e l'introduzione della polizia medica nella Lombardia austriaca, F. Della Peruta, a cura di, Sanità e società, vol. IV, Veneto, Lombardia, Piemonte, Liguria. Secoli XVII-XX, Udine: Casamassima, 1989;95-107.

[26] Mongiardini GA. Introduzione alla seduta pubblica della Società Medica d'Emulazione del Presidente G. A. Mongiardini il giorno 26 novembre 1801, in Memorie della Società Medica di Emulazione di Genova, Tomo I: primo quadrimestre. Genova: Stamperia Porcile e C., 1801;III-VI.

[27] Bologna E, Martini M. The history of smallpox vaccination in Italy: the vaccination campaign in the Ligurian Re-public between the end of the Ancien Régime and the advent of the Napoleonic period (1797-1805). J Prev Med Hyg 2026;67:E121-E8. https://doi.org/10.82082/2421-4248/jpmh2026.67.1.3903.

[28] Marchelli L. Memoria sull'inoculazione della Vaccina del chirurgo Luigi Marchelli, membro dell'Istituto Nazionale. Letta nella Società Medica di Emulazione di Genova, il giorno 23 luglio 1801, anno V. Genova: Stamperia della Gazzetta Nazionale 1801.

[29] Batt W. Distinzione necessaria fra la vaccina e gli errori, o negligenze di quelli che la praticano. Genova: Stamperia della Società Medica di Emulazione, 1802.

[30] Batt W. Sull'origine dell'innesto della Vaccina. Genova: Stamperia della Società Medica di Emulazione 1802.

[31] Batt W. Sulla Vaccina di Jenner. Genova: Stamperia della Gazzetta Nazionale, anno IV della libertà 1801.

[32] Martini M, Valchi L, Orsini D, Piccardo A. The fight against smallpox during the Savoy kingdom in Genoa between 1815 and 1859. J Prev Med Hyg 2024;65:E296-E302. https://doi.org/10.15167/2421-4248/jpmh2024.65.2.3335.

[33] Paolocci C (a cura di). Sampierdarena tra documenti e cartografia. Dalle ville cinquecentesche al nuovo assetto urbanistico otto-novecentesco, Genova: Associazione Amici della Biblioteca Franzoniana 2026.

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Errata
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ORIGINAL ARTICLE

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